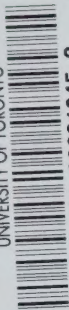


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BURLINGTON ORTHODONTIC RESEARCH CENTRE

PROGRESS REPORT SERIES

No. 5

1959 - 1960

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BURLINGTON ORTHODONTIC

RESEARCH CENTRE

PROGRESS REPORT SERIES

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Programme

for

Annual Meeting, Burlington Orthodontic Research Centre

November 16, 1960

Introductory RemarksDr. Gordon Nikiforuk

Research Reports

Interrelations of Malocclusion Manifestations and Etiologic

Factors Dr. Robert Grainger

Tooth Size, Spacing-crowding, Arch Relationships and Arch

Dimension Dr. Stuart Hunter

Summary of Year's Work and

Future Plans Dr. Egil Harvold

Discussion

Closing Comments Dr. R. G. Ellis

This publication comprises the fifth in the report series on the
Burlington Orthodontic Research Centre.

Public Health Project 605 - 12 - 7

Administration and Staff

This year, the centre has been under the direction of Professor E. P. Harvold, L.D.S., Ph.D., Professor Gordon Nikiforuk, D.D.S., M.Sc.D. has been the advisor on administrative policy and Associate Professor Robert M. Grainger D.D.S. M.Sc.D. has as consultant, taken an active part in the research activities.

The following constitute the present staff of the centre:

Position	Name	Address
Research Fellow and Clinic Administrator	Margaret Hatton B.A., Ph.D.	Department of Zoology, U. of T.
Orthodontic Technician and Secretary	Mrs. Margaret Holbrook	Burlington
Orthodontic Assistant and Stenographic-Receptionist	Mrs. Katharine Scarlett	Burlington
Orthodontists	Robert Boyko, D.D.S., M.Sc.	Toronto
	Allen Feldman, D.D.S.	Toronto
	W. Stuart Hunter, D.D.S., Ph.D.	Burlington
	Albert Jarvis, D.D.S., M.Sc.	St. Catherines
	C. Bruce Morrow, D.D.S., M.Sc.	Hamilton
Pedodontists	W. H. Feasby, D.D.S.	Hamilton
	Lorne Scott, D.D.S.	Brantford

EXTRAMURAL ACTIVITIES 1959 - 60

1. Dr. Hatton and Dr. Popovich attended the Conference on Growth at the National Institute of Health, Bethesda, Md., April 28-30th.
2. At the American Academy of Pedodontics, held at Boulder, Colorado, August 29-31st, Dr. Grainger was guest essayist and presented a paper entitled "Epidemiology of Malocclusion". At the same meeting, Dr. Lorne Scott read a paper on "The Extraction of Deciduous Cuspids to Facilitate the Eruption of Permanent Incisors".
3. At the annual meeting of the Canadian Dental Association held in Ottawa September 25-26th, Dr. Hatton presented an exhibit which illustrated the main areas of research included in the Burlington project.
4. A booklet entitled "Interceptive Orthodontics" by Dr. Harvold and Dr. Hatton is to appear as the November issue of Practical Dental Monographs.
5. In March Mrs. Holbrook spoke to the Burlington Federation of Women Teachers about the function of the Research Centre.

SUMMARY AND FUTURE PLANS

SUMMARY:

Initiated in 1952, the project had as its aims three main considerations. It may be worthwhile, at this stage, to "take stock" of achievements generally with respect to the original frame of reference.

AIMS OF THE PROJECT:

The primary aim of the study was to evaluate the relative efficacy of preventive-interceptive orthodontic therapy. It readily becomes apparent that an evaluation of such dimensions requires both intensive and extensive comparison and analysis; at the very outset, much must be learned about the changing habits of growth and these in the population generally. Thus, a prerequisite to the primary aim was the accumulation of a library of records which might be used to illustrate the characteristics of maturation, including those of the cranio-facial complex, in a representative group of children. Finally, an attempt had to be made to assess the relative roles of hereditary and environmental factors in governing maturational change.

Potential Contribution of the Project to Public Health Problems.

As shown in Report #3 (p.12, Demography of Burlington), the records* which constitute the foundation material are essentially those of a representative group of Canadian children, and include not only cross-sectional material and serial reports but also many families. Thus, the

* Type and number are shown in each of Reports 1, 2, 3, 4 and also in the present report.

type of material and the sample from which it was procured serve to provide an invaluable collection of data for use in a variety of problems related to work in dental public health. It is worth emphasizing that the information which is available has not been derived from a rather highly selected group of individuals, such as that which visits the average practitioner, rather it is a picture of so-called normal and abnormal growth in children making up our population. It must surely be conceded, that if any real attempt is to be made to deal with the ever increasing demands of our society for orthodontic therapy, the solution can only be derived from a project such as Burlington. For this very reason, it is appropriate to point out that in its present stage there exists a real need for additional staff and facilities if the potential of the project is to be properly exploited.

SOURCES OF INFORMATION PROVIDED BY THE PROJECT:

The studies which have already been completed or which are now in progress, illustrate the main sources of information provided by the project. These comprise four main groups: epidemiology, characteristics of maturation, genetics and diagnosis and preventive-interceptive therapy. In this year's report there is a cumulative table of the various tracings and measurements which have been completed in connection with investigations either completed or in progress.

SOURCE I - EPIDEMIOLOGY:

The first review of an epidemiological nature was presented in Report #2. In this year's report Grainger, writing on "Inter-relations of Malocclusion Manifestation and Etiologic Factors" has developed this material more fully. As he justly comments: "...knowledge of the physiology, anatomy, embryology, etc. are the final means of understanding malocclusion, (but) mathematical

checking of clinically derived concepts is very valuable. Conversely, mathematically suggested syndromes may throw considerable light on some still unsolved clinical problems".

SOURCE II - CHARACTERISTICS OF MATURATION: (a) DESCRIPTIVE MATERIAL

Information on the characteristics of maturation may be purely descriptive. The first study of this type was illustrated in Report #2. This study, conducted by the staff, showed certain values for a number of cranio-facial traits in a number of children at various ages, classified according to the Angle System. Harvold and Hatton in "Some Cranio-facial Characteristics in Representative Groups of Children at 6, 8, 10 and 12 years of age", illustrate the distribution of certain characteristics in the population at different age levels; here no classification system has been employed.

This year, Hunter, reporting on "Tooth Size, Spacing, Crowding, Arch Relationship and Arch Dimension", has indicated the behaviour pattern of the teeth in the population at age 6 years and again in the same children at 9 years. Feldman is presently carrying out a similar study on children at age 12 years.

SOURCE II - CHARACTERISTICS OF MATURATION: (b) INTERRELATED TRAITS

Investigations on the possible association of certain cranio-facial features include that conducted by Popovich, entitled "The Incidence of Sucking Habits and its Relationship to Occlusion in 3 year old Children" which appeared in Report #1 . *

* See footnote appended.

- * That report also contains the summaries of seven Master of Science theses. These are as follows: -
- Posen's "Vertical Height of the Body of the Mandible and the Occlusal Level of the Teeth in Individuals with Cleft and Non-Cleft Palates";
- Perry's "A Lateral Cephalometric Study of the Dento-Facial Morphology of three year old children having Normal Occlusion and Distocclusion (Without Habits)";
- Mitchell's "A Study of the Dento-Facial Morphology of a Group of 3 year old Children with Class II Div.1 (Angle) Malocclusion (with a sucking habit)";
- Spracklin's "An Investigation of the Natural Occlusal Plane for Deciduous Teeth and the Variation of the Individual Occlusal Planes from Average Estimates by Age and Sex";
- Landsberg's "A Study of Cephalometric Reference Planes Used in Recording Anteroposterior Denture Base Relationships";
- Fisk's "The Relationship of a Weight/Height Index to the Total Number of Erupted Canine, First Bicuspid, Second Bicuspid and Second Molar Teeth in a Sample of 10 year old children";
- Latif's (assisted by Boyko) "An Electromyographic Study of the Temporalis Muscle".

Other reports of this type are those by Hatton on the process of eruption. The first of these appeared in Report #2, entitled "The Relation between Intra-alveolar Tooth Movement and Clinical Eruption"; the second (Report #3), "Some Characteristics of Eruption in ^{NEUTROCCUSION} Malocclusion and Class II Malocclusion Cases". Another study of this general type is that by Scott, carried out this year, called "The Extraction of Deciduous Cuspids to Facilitate the Eruption of Permanent Incisor Teeth".

Harvold, introducing a new series of investigations aimed primarily at evaluating mandibular morphogenesis in relation to other factors, directed the study "Gonial Angle and Mandibular Length in Normal Children and Children with Cleft Palate", which was carried out by Bimm, Eisner and Ibanez, and completed this year.

Coupe (p.30, Report #4) and Ross (p.29, Report #4) are presently conducting investigations which compare morphological features of the upper facial skeleton and the cranial base in normal children (from the project) and those suffering from cleft palate.

SOURCE III - GENETICS

The plan of investigation for determining hereditary factors in cranio-facial development was first shown in Report #4 and in the present report. The total number of families taking part in this project is indicated.* It should be emphasized that the basic aim of this investigation is not an evaluation of heretability values, but rather a determination of mode of inheritance of certain clinically significant traits. The desirability of this approach is readily apparent: the practitioner is anxious to know what certain traits, which are observed during childhood, will be like at adulthood. An attempt must be made, therefore, to weigh the constant effects of environment

* Report # 5, 1960

and heredity as the child moves toward adulthood, that is, the state when face, jaws and teeth assume a more or less permanent relation among one another. But the problem here is not the extent to which the offspring, as an adult, resembles the parent, but rather, (since this is a matter of prevention), it is the recognition of certain features which are indicative of incipient problems, and the extent to which these are the result of inheritance. The genetics investigations, therefore, embrace two broad concepts; first, maturational change within each family unit, and second, the extent to which traits observed in parents are transmitted.

SOURCE IV - DIAGNOSIS AND PREVENTIVE - INTERCEPTIVE PROCEDURE

The total number of children who have visited the clinic this year for records is shown in the present report. Annual records are taken for the most part by Morrow, Feasby and Boyko, but almost all the staff take some records. Initial diagnosis is made when the records are taken, but the complete group of serial children is reviewed by all the staff at regular staff meetings.

The number of cases and type of treatment being administered are shown in this report. Like the routine of taking records, almost all the staff are carrying out some treatment. Scott, Boyko and Jarvis are, however, conducting most of this part of the programme. When Popovich and Johnston left the project, the cases which they had started were divided amongst the staff.

FUTURE PLANS:

Assessing Preventive-interceptive Therapy.

In order to evaluate the relative efficacy of preventive-interceptive procedures various analyses must be carried out on the control data which have been derived from the 6, 8, 10 and 12 year old children. The facial characteristics of these cases have been described in this year's report by Harvold and Hatton. The results of further analysis of the controls (untreated) cases, will form a basis of comparison with the serial (treated) group, that is, the group which has been subjected to preventive-interceptive therapy. In essence, the plan of this investigation will be to establish the degree to which certain cranio-facial characteristics are correlated with malocclusion in the control children. Assuming that these cranio-facial characteristics occur with equal frequency in the serial (treated) cases, then a study of the prevalence of malocclusion in this group is an index of the effects of therapy. In addition, such information may permit a clearer delineation of types of malocclusion that are readily amenable to interceptive therapy and those that require more extensive treatment. This is valuable information for the application of orthodontic procedures to public health.

Assessing the Effects of Changes in the Population.

It will also be necessary in the near future to make some assessment of the relative effects of changes which have occurred in the population since the project was first started. In 1952 the population of the town was approximately 8000. As a result of increase in this population and also because a number of surrounding townships have been incorporated, the population of Burlington is now approximately 34,000. From the point of view of the applicability of the findings of the project to the population

generally, it is essential to know what effect the changes of a considerably increased population have on the relative prevalence of malocclusion. For this purpose, representative groups of children from the existing population will be compared with their counterparts, the records of whom are already included in the clinic's files.

Characteristics of Maturation.

Studies on the effects of mandibular morphogenesis on the developing dentition introduced by Hargold, will be continued. Hatton's work on eruption will be expanded to incorporate the effects of changes in mandibular form.

Investigations into the relation between tooth material (the disposition of the teeth) and arch dimensions will be continued by Hunter and Feldman.

Feasby will develop an avaluation of levels of maturation indicated by the carpal index.

With the gradual increase of the family material, further analyses of these records will be expanded by Hatton.

	Age in Years						
	1	2	3(4)*	4	5	6(7)*	7(8)*
1934-39	20	25	47	27	22	—	—
1939-49	20	27	22	24	22	21	12
Additions	—	—	5	—	—	0	15

* The figures in brackets refer to the age group in which the subjects were first seen.

RECORDS

The collection of annual records has continued this year and 223 were obtained for the serial group up to the end of October 1960. The current totals for each group are presented together with those for the previous year (Report #4).

	<u>Age in Years</u>							
	3	4	5	6	7	8	9	10
1958-59	238	307	294	284	206	140	87	1
1959-60	238	307	294	284	273	260	193	71
Additions -	-	-	-	-	27	20	106	70

The size of the control group samples remains the same as last year for ages 6, 8, 10 and the original 12 year sample. However, the 6 year sample (already seen again at 9 years) is being seen again at 12 years. The totals are now as follows:

	<u>Age in Years</u>						
	6	8	9(6)*	10	12	12(6)*	16(10)*
1958-59	303	222	257	219	218	—	—
1959-60	303	222	262	219	218	85	16
Additions	—	—	5	—	—	85	16

* The figures in brackets refer to the age group in which the subjects were first seen.

RECORDS

The collection of annual records has continued to the year and 231 were obtained for the period group up to the end of October 1960. The current totals for each group are presented together with those for the previous year (Report 44).

Age in Years

	3	4	5	6	7	8	9	10
1958-59	238	307	294	284	206	140	27	1
1959-60	238	307	294	284	273	260	193	71
Additions -	-	-	-	-	27	20	104	70

The size of the control group samples remains the same as last year for ages 6, 8, 10 and the original 12 year sample. However, the 9 year sample (already seen again at 9 years) is being seen again at 12 years. The totals are now as follows:

Age in Years

	6	8	9(6)*	10	12	12(6)*	12(10)*
1958-59	303	222	227	219	218	---	---
1959-60	303	222	268	219	218	85	16
Additions -	---	---	2	---	---	85	16

* The figures in brackets refer to the age group in which the subjects were first seen.

It will be observed that the 10 year sample is now being seen again at age 16.

Finally, 29 more parent records have been obtained, bringing these totals to 132 fathers and 129 mothers.

TREATMENT

During the year 32 treatment cases were completed, bringing the total number of cases under active treatment down to 191. Of course, the records of the entire serial group continue to be examined and evaluated carefully each year. A summary of the cases under treatment will be found in Table I, page 14.

MEASUREMENTS AND TRACINGS

Considerable progress has been made in the accumulation of tracings and of certain basic measurements. Table II is a summary of the number and type of tracings made to date, and Table III summarizes not only the measurements completed on the tracings but also measurements made on the plaster casts.

TABLE I

TYPE OF TREATMENT		PREVENTIVE		INTERCEPTIVE		CORRECTIVE		TOTAL
TYPES OF CASES		Fixed Appliance	Removable Appliance	With Appliance	No Appliance	tooth size and jaw size Discrepancies Discing Extraction	Simple Banding	Removable Appliance
14	Active	8	14	11	5	14	17	28
	Deferred because of							
	Poor co-operation	3		5				3
	Operative work needed	5	2				1	
	Observational	7	2	11		11	5	10
	Completed	5	1	8	1	3	6	8
								32

TABLE I - Summary of treatment undertaken during 1959-60

according to type of case and type of treatment.

TABLE II

A SUMMARY OF TRACINGS included in the Files

Investigators: Boyko, Bimm, Eisner, Hatton, Ibanez Johnston

NUMBER and TYPE of CEPHALOGRAM

SAMPLE	AGE IN YEARS	LATERAL HEAD PLATE		OBLIQUE HEAD PLATE	
		REST	CENTRIC	RIGHT	LEFT
SERIAL	3				
	4		40		
	5		192		
	6		47		
	6	302	342	103	103
CONTROL	8	221	261	40	40
	10	204	244	40	40
	12	210	210	-	-

An evaluation of Cranio-facial Characteristics in the Population and their Relative Significance as Predisposing Factors in the Development of Malocclusion.

An introductory report by E. P. Harvold and M. E. Hatton.

In the last report, (Report 4, 1959, pp.12-22) the discussion on the demography of the town of Burlington served to substantiate the view that the population on which the study was being conducted is essentially a representative one. This means that the findings are applicable, for the most part, to the population of the Province as a whole.

The extent and severity of the problems of malocclusion as they occur in the population are factors to be reckoned with. From the point of view of dental public health, the questions which must be confronted are as follows: -

- 1) Do certain cranio-facial characteristics occur with greater or lesser frequency in this population?
- 2) Do certain of these characteristics act as predisposing factors in the development of malocclusion? If this is the case, then what is most likely to happen to the frequency of defects if there are marked changes in the population?
- 3) What is the frequency with which children of various ages are afflicted with different types of malocclusion?
- 4) How does maturational change affect the various types of defects?
- 5) Are there any patterns of growth which are comparatively readily detected as expressions of incipient malocclusion? Of these, which are comparatively readily prevented or intercepted?
- 6) Which types of growth patterns are of a defective and complex nature requiring complex therapy, including elaborate appliances and a considerable amount of expert attention?

These six questions serve to illustrate the expansive nature of the basic aim of the project, that is, an evaluation of the relative efficacy of preventive-interceptive procedures. Since the data which have been accumulated over the past eight years is such that these problems may now be attempted, it is well at this stage to clarify the method of investigation which is to be adopted.

Material

The material in the files includes records of 85% to 90% of the population of the town (1952 - 1954) in the age groups three, six, eight, ten and twelve years. The three year old children constitute the original serial sample. These cases have been seen annually and since they have been subjected to the preventive-interceptive programme they constitute the treated sample. The four remaining groups of children (cases aged six, eight, ten and twelve years) have received no treatment and thus they constitute the control sample. All the children are from the same population (see Report 4, 1959) and all have been under the same general environmental factors; the two groups differ in one major respect, viz, the special programme of treatment which has been accorded the serial cases.

Method

An attempt is presently being made to evaluate the efficacy of the preventive-interceptive programme. For this purpose, certain criteria have been established which provide a means of comparing the treated and untreated cases. In essence, the object is to determine whether or not certain cranio-facial features act as predisposing factors in the development of certain

types of occlusion. The frequency of these possible predisposing factors will be observed in both the treated and untreated cases and similarly the frequency of certain types of occlusion. Although it is common procedure in the practice of orthodontics to use the Angle classification for describing occlusion, to adopt such a procedure here would not be suitable, since it would not provide the answer to the primary question. The aim here is to describe the population according to certain facial types, thus, to describe types of occlusion and their related characteristics as a first step, would be of little value and might even be misleading.

The cranio-facial features which have been considered include: -

1) the cranio-facial index; 2) facial angle; 3) A-B relation; 4) cranio-occlusal angle. Figures 1 - 4 which are appended illustrate these characteristics which have all been derived from lateral cephalograms. Another series of characteristics, taken from oblique and postero-anterior cephalograms, will also be examined.

Results

Measurements for the four characteristics listed have been made from tracings of the complete control sample. Frequency distributions for these data have also been completed.

Proposed Research

Future work will be aimed at answering the six questions indicated in the introduction. Because of the scope of these questions, such an undertaking will involve consideration of all the major research investigations, either already completed, or presently being undertaken. These are listed in the present report under the section entitled, Summary. The immediate

considerations of the present study will be the analyses of the distributions of various cranio-facial characteristics, according to age and sex in the treated and untreated cases. Comparisons of the characteristics of occlusion in the two groups should provide information on the relative efficacy of the treatment programme which has been adopted. This procedure should also serve to indicate the more complex cases which have failed to show any effects of the therapy which has been applied.

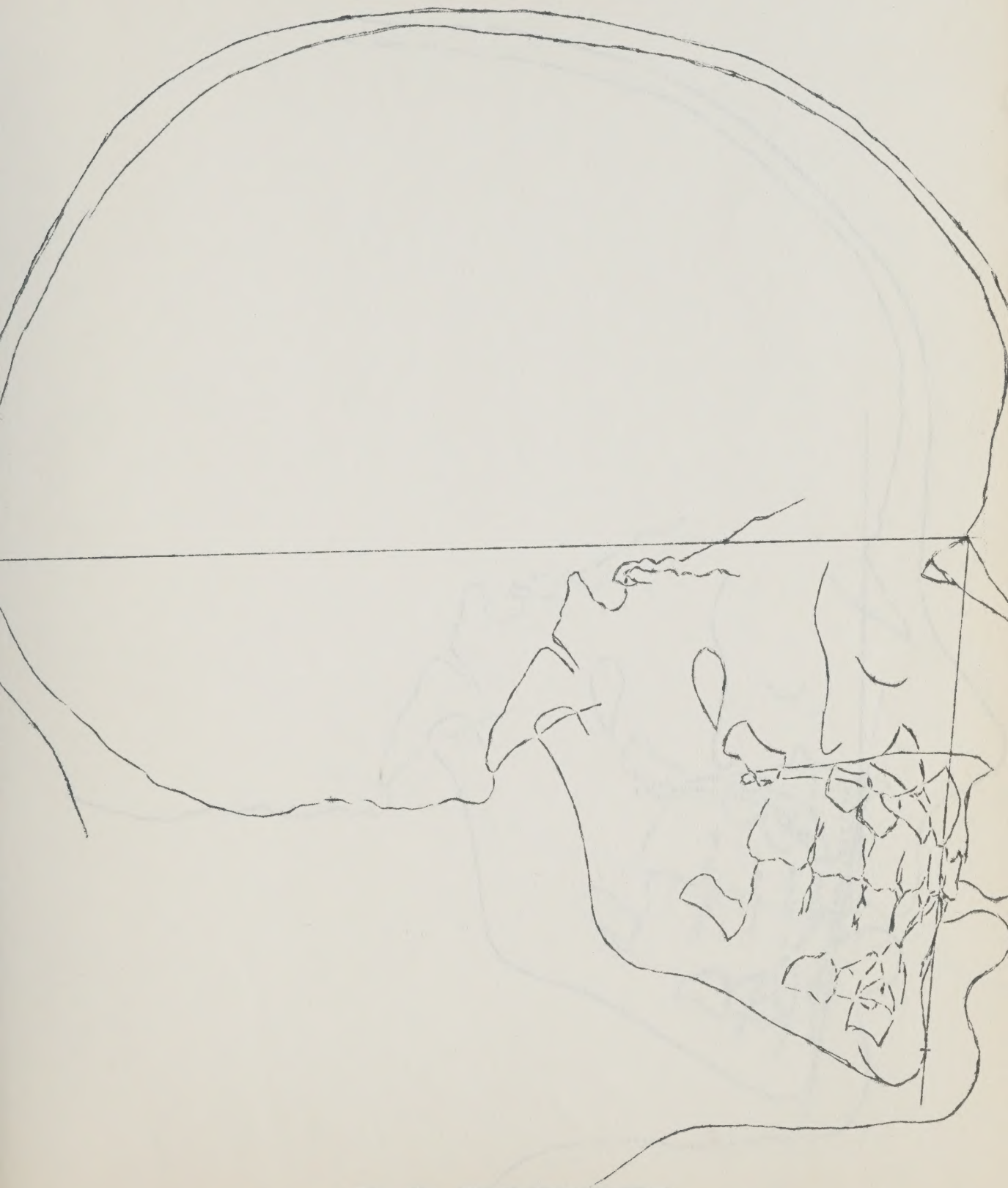


FIG. 1: CRANIO-FACIAL INDEX

Cranio-facial Characteristics
in the Burlington Population

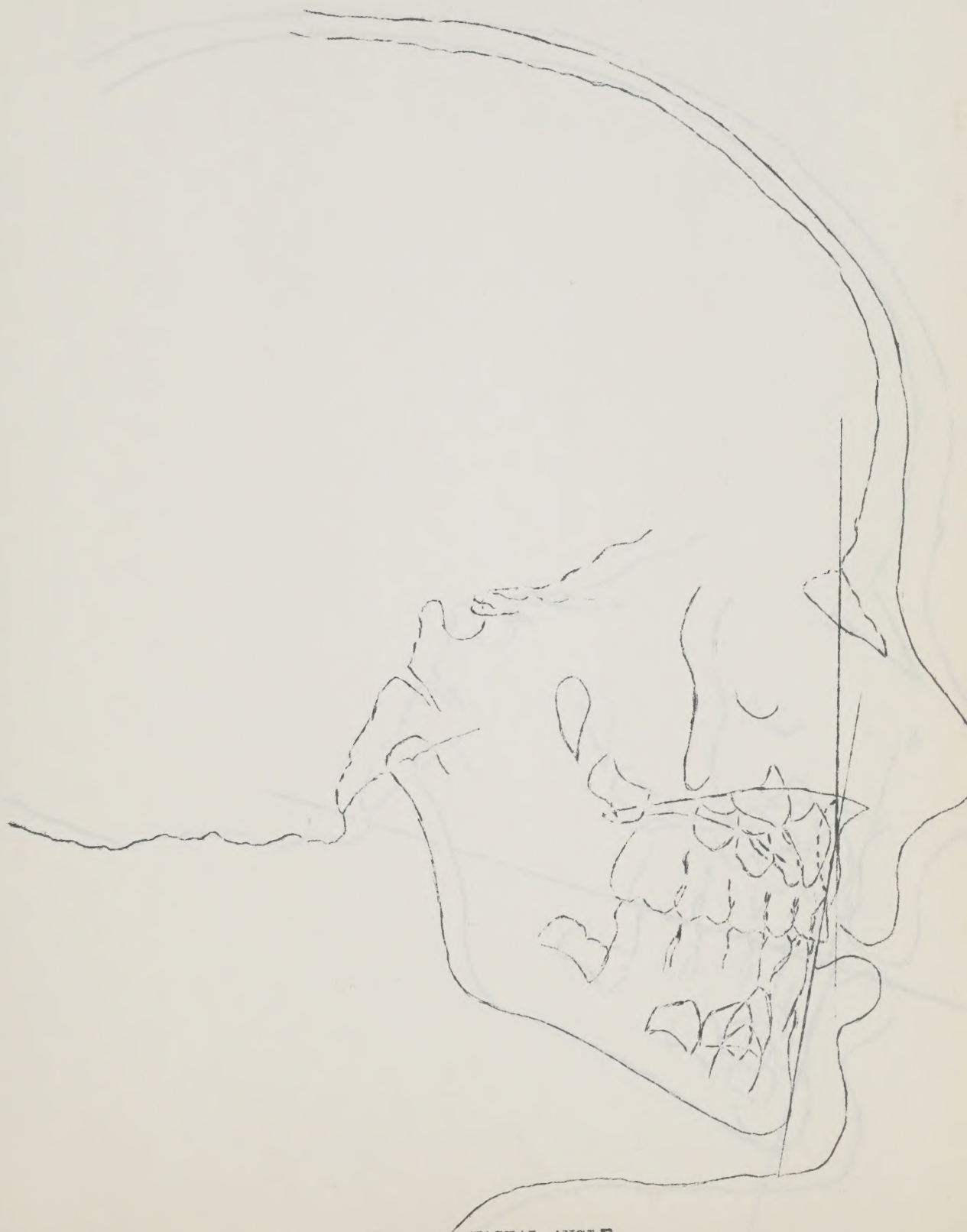


FIG. 2: FACIAL ANGLE

Cranio-facial Characteristics
in the Burlington Population

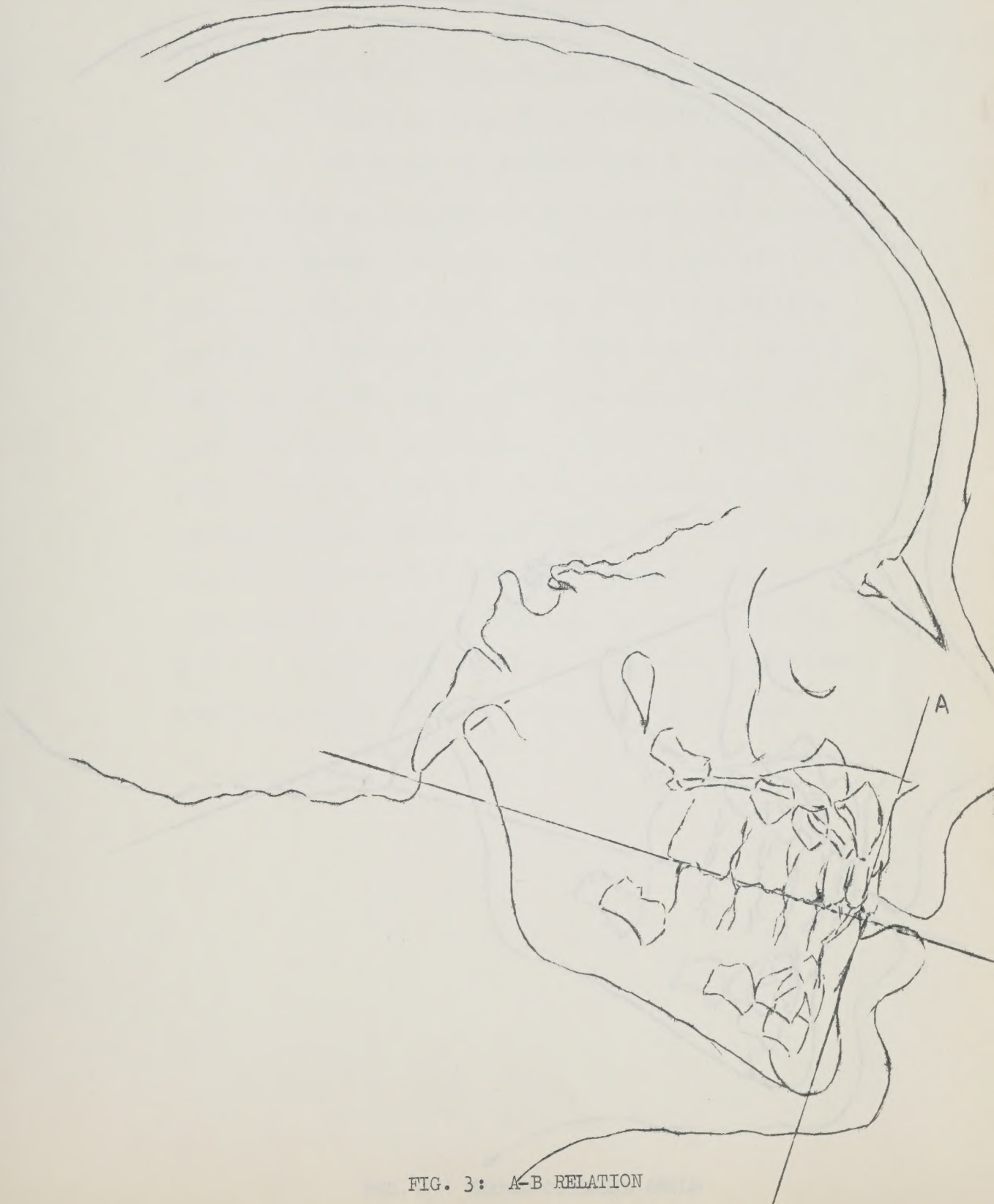


FIG. 3: A-B RELATION

Cranio-facial Characteristics
in the Burlington Population

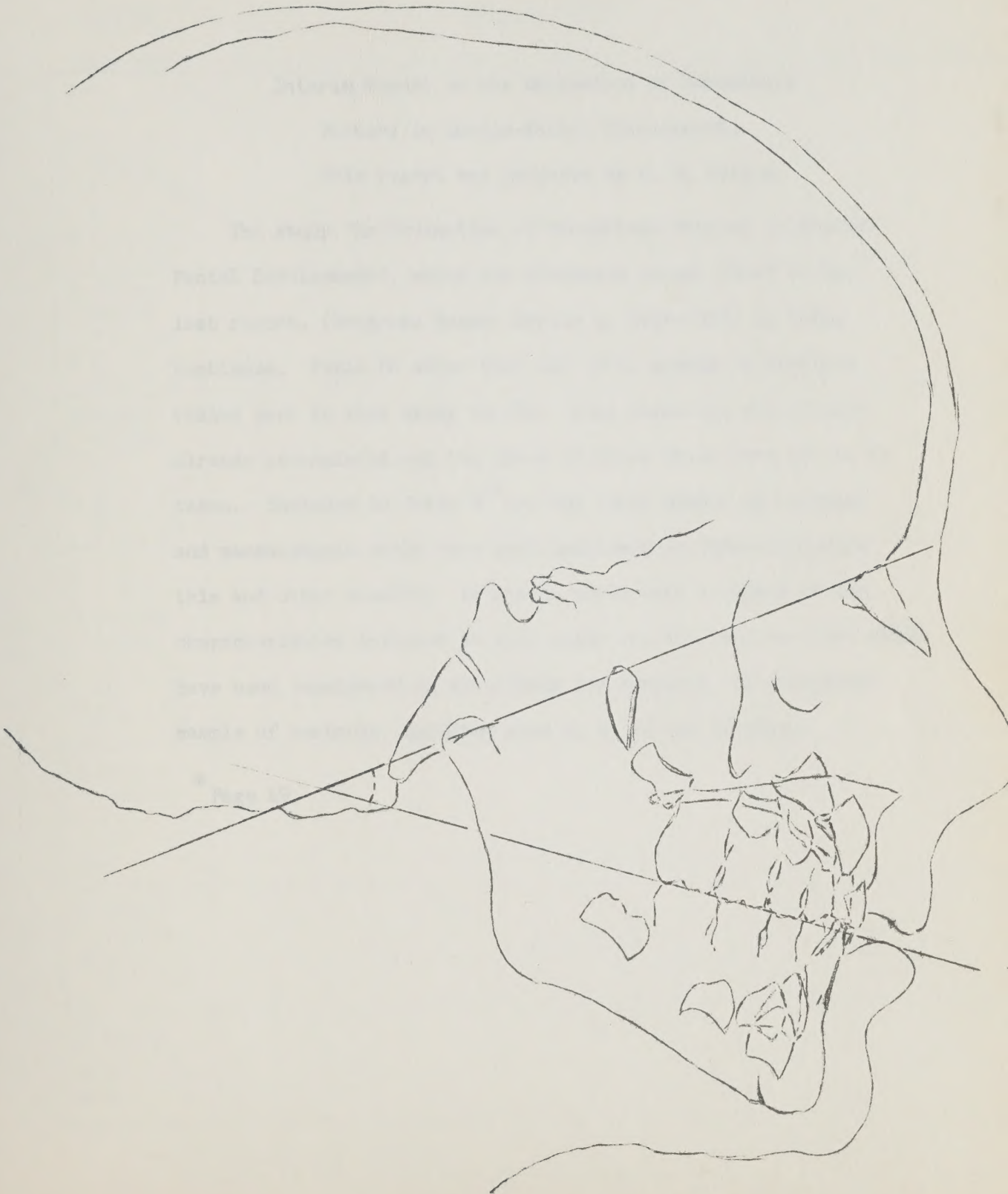


FIG. 4: CRANIO-OCCLUSAL ANGLE

Interim Report on the Evaluation of Hereditary
Factors in Cranio-Facial Development.

This report was prepared by M. E. Hatton.

The study "An Evaluation of Hereditary Factors in Cranio-Facial Development", which was discussed on pp. 23-27 of the last report, (Progress Report Series 4, 1958-1959) is being continued. Table IV shows that the total number of families taking part in this study is 174. Also shown are the records already accumulated and the dates of those which have yet to be taken. Included in Table IV* are the total number of tracings and measurements which have been completed in connection with this and other studies. It may be noted that a number of the characteristics involved in this study are the same as those which have been considered in describing the complete (Burlington) sample of controls, children aged 6, 8, 10 and 12 years.

* Page 49

TABLE IV * FAMILIES TAKING PART IN THE BURLINGTON PROJECT

FAMILY		AGE IN YEARS																
Sex	Birth	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Adult	
<u>A</u>																		
I	Mother																v	
	Father																v	
	F '45								v				v					
	F '47										v		'61					
#	F '51	v	v	v	v	v	v	v	61	62	'63	'64	'65	66	67			
	F '53				v			'62			'65		'67					
2																		
	Mother																v	
	Father																v	
	F '47										v		'61					
#	F '50	v	v	v	v	v	v	v	60	61	62	63	64					
	F '54			v				63			66		68					
3																		
	Mother																v	
	Father																v	
	M '42										v							
	M '47										v		61					
#	M '51	v	v	v	v	v	v	v	61	62	63	64	65					
	M '53				v			62			65		67					
<u>B</u>																		
4																		
	Mother																v	
	Father																v	
	T '42										v							
	M '48				v			v										
#	F '49		v	v	v	v	v	v	v	61	61	62	63					
	F '52				v			61			64		66					
5																		
	Mother																v	
	Father																v	
	F '46						v						v					
	M '48				v			v			v		62					
#	F '51	v	v	v	v	v	v	v	61	62	63							
6																		
	Mother																v	
	Father																v	
#	M '51	v	v	v	v	v	v	v	61	62	63							
	M '55			v	61			64			67							
7																		
	Mother																	
	Father																	
#	M '50		v	v	v	v												
#	M '51	v	v	v														

v = Records already taken
 Dates of Future Records are also shown
 # = Child in "Serial Group"

FAMILIES TAKING PART IN THE BURLINGTON PROJECT

FAMILY		AGE IN YEARS															
Sex	Birth	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Adult	
<u>B</u> (cont'd)																	
8	Mother Father M.F. '46						vv			vv							
9	Mother Father M.M. '42										vv						
10	Mother Father M.M. '48				vv			vv			60		62				
11	Mother Father F '48 # F '50		v	v	v	v	v	v	v	61	v 62		62 64			v v	
12	Mother Father # M '51 M '54	v	v	v	v v	v	v	v 63	61	62	63 66	64	65 68			v v	
13	Mother Father F '45 # F '50		v	v	v	v	v	v	v					v		v v	
14	Mother Father F '47 M '46 # M '50		v	v	v	v		v v	v	61	62		60			v v	
15	Mother Father F '46 # F '50 M '52	v	v	v	v	v		v 60	v	60 62	61 64		64 66	v		v v	
16	Mother Father F '43 F '45 M '46 F '48 F '51	v	v	v	v	v	v	v	v	61	62	v 63	64 65	v		v	

FAMILIES TAKING PART IN THE BURLINGTON PROJECT

FAMILY		AGE IN YEARS															
Sex	Birth	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Adult
C (cont'd)																	
26	Mother																v
	Father																
	F '49				v			v			61						
#	M '51	v	v	v	v	v	v	60									
27	Mother																v
	Father																v
	F '48				v			v			v		62				
#	F '51	v	v	v	v	v	v	v	61	62	63	64	65				
28	Mother																v
	Father																v
	F '44								v						v		
#	F '50		v	v	v	v	v	v	v								
29	Mother																v
	Father																v
	F '48				v			v			60		62				
#	M '50	v	v	v	v	v	v	v	60	61	62	63	64				
30	Mother																v
	Father																v
	M '45								v								
#	M '50	v	v	v	v	v	v	v	60	61	62	63	64				
31	Mother																v
	Father																v
#	M '51	v	v	v	v	v	v	v	61	62	63	64	65				
	M '53					v		62			65		67				
32	Mother																v
	Father																v
	F '47						v					v	61				
#	F '50	v	v	v	v	v	v	v	v	61	62	63	64				
33	Mother																
	Father																
	M M '42										vv						
34	Mother																v
	Father																
	F '46						v					v	60				
	M '49				v			v			61		63				
#	F '52	v	v	v	v	v	v	61	62	63	64	65	66				

FAMILIES TAKING PART IN THE BURLINGTON PROJECT

FAMILY		AGE IN YEARS																
Sex	Birth	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Adult	
<u>C</u> (cont'd)																		
35	Mother																	
	Father																	
	F '46						v						60					
#	F '50		v	v	v	v	v	v	v	61	62	63	64					
36	Mother																v	
	Father																	
	F '48				v			v			60		62					
#	M '51	v	v	v	v	v	v	60	61	62	63	64	65					
<u>D</u>																		
37	Mother																	
	Father																	
#	F '50		v	v	v	v	v	v	v	61	62	63	64					
	F '51							v			63							
	F '53					v		62			65		67					
38	Mother																	
	Father																	
	M M '42										vv							
39	Mother																	
	Father																	
	F '46							v					60					
	M '48											60						
#	M '51	v	v	v	v	v	v	v	61	62	63	64	65					
40	Mother																	
	Father																	
#	M '51	v	v	v	v	v	v	v	61	62	63	64	65					
	M '54				v			63			66		68					
41	Mother																	
	Father																	
	M '48				v			v				v	62					
#	F '49		v	v	v	v	v	v	v	60	61	62	63					
	M '54				v			63			66		68					
42	Mother																v	
	Father																v	
	M '46						v						60					
#	F '51	v	v	v	v	v	v	v	61	62	63		65					
	F '54				60						66		68					

FAMILIES TAKING PART IN THE BURLINGTON PROJECT

FAMILY		AGE IN YEARS																	
Sex	Birth	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Adult		
<u>D</u> (cont'd)																			
43	Mother																	v	
	Father																	v	
	M '48				v						v		62						
#	F '51	v	v	v	v	v	v	60	61	62	63	64	65						
	M '53					v		62			65		67						
44	Mother																	v	
	Father																	v	
#	F '51	v	v	v	v	v	v	v	61	62	63	64	65						
	F '52						60	61			64		66						
45	Mother																		
	Father																		
	F '48				v			v			60		62						
#	M '51	v	v	v	v	v	v	v	61	62	63	64	65						
	M '54			v	60			63			66		68						
46	Mother																	v	
	Father																	v	
#	F '51	v	v	v	v	v	v	v	61	62	63	64	65						
	F '53					v		62			65		67						
47	Mother																	v	
	Father																	v	
	F '48				v			v			v		62						
#	M '51	v	v	v	v	v	v	v	61	62	63	64	65						
	F '53					v		62			65		67						
48	Mother																	v	
	Father																	v	
	M '42																		
#	M '51	v	v	v	v	v	v	60	61	62	63								
49	^E Mother																	v	
	Father																	v	
	M '42																		
	FF 47						vv				vv		61				v		
50	Mother																	v	
	Father																	v	
	M '43				v			v			v		62						
#	F '50	v	v	v	v	v	v	v	60	61	62	63	64						
	F '53				v			62			65		67						

FAMILIES TAKING PART IN THE BURLINGTON PROJECT

32

FAMILY		AGE IN YEARS																	
Sex	Birth	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Adult		
E (Cont)																			
51	Mother																		
	Father																		
M	'44								v										
F	'46						v												
# M	'51	v	v	v	v	v	v	60	61	62	63	64	65						
F																			
52	Mother																	v	
	Father																	v	
M	'42										v								
M	'46						v						60						
# M	'50	v	v	v	v	v	v	v	60	61	62	63	64						
53 Mother																		v	
	Father																	v	
# F	'51	v	v	v	v	v	v	60	61	62	63	64	65						
F	'53				v			62			65		67						
54 Mother																		v	
	Father																	v	
# M	'50		v	v	v	v	v	v	v										
# F	'51	v	v	v	v	v	v	v											
M	'53				v			62			65		67						
55 Mother																		v	
	Father																	v	
F	'49				v		v				61		63						
# M	'51	v	v	v	v	v	v	v	61	62	63	64	65						
56 Mother																		v	
	Father																	v	
M	'48										60		62						
M	'49				v				v		61		63						
# M	'51	v	v	v	v	v	v	v	61	62	63	64	65						
M	'55			v	61			64			67		69						
57 Mother																		v	
	Father																	v	
# F	'49		v	v	v	v	v	v	v	60	61	62	63						
# M	'51	v	v	v	v	v	v	v	61	62	63	64	65						
F	'55			v	61			64			67		69						
G																			
58	Mother																		
	Father																		
F	'43										v								
# F	'49		v	v	v	v	v	v	v	60									

FAMILIES TAKING PART IN THE BURLINGTON PROJECT

FAMILY		AGE IN YEARS																
Sex	B irth	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Adult	
G (cont)																		
59	Mother																	
	Father																	
	M '48				v			v			v		62					
#	M '50	v	v	v	v	v	v	v	61	62	63	64	65					
60	Mother																	
	Father																	
	M M'48				vv			vv			60		62					
61	Mother																	
	Father																v	
	F '49				v			v			61		63					
#	M '50		v	v	v	v	v	v	v	61	62	63	64					
62	Mother																	
	Father																	
	F '47																	
#	F '51	v	v	v	v	v	v	60	61	62	63	64	65					
	F '55			60				64			67		69					
63	Mother																	
	Father																v	
#	F '51	v	v	v	v	v	v	60	61	62	63	64	65					
	F '53				v			62			65		67					
64	Mother																	
	Father																	
	F '44								v									
	M '48				v			v			60							
#	M '51	v	v	v	v	v	v	60	61	62	63	64	65					
65	Mother																	
	Father																	
#	F '50		v	v	v	v	v	v	60	61	62	63	64	65				
#	M '51	v	v	v	v	v	v	60	61	62	63	64	65					
66	Mother																	
	Father																v	
	M '48				v			v			60		62				v	
#	F '50		v	v	v	v	v	v	v	61	62	63	64					
	F '52						v	61			64		66					

FAMILIES TAKING PART IN THE BURLINGTON PROJECT

34

FAMILY		AGE IN YEARS																
Sex	Birth	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Adult	
G (cont)																		
67	Mother																	
	Father																	
	FM '45								vv									
68	Mother																	
	Father																	
	M '43										v							
	M '46						v						60					
#	M '49		v	v	v	v	v	v	v	60	61	62	63					
69	Mother																	
	Father																	
	F '47											v						
#	F '51	v	v	v	v	v	v	v	61	62	63	64	65					
	F '53					v		62			65		67					
70	Mother																v	
	Father																v	
	F '48											60			62			
#	F '50		v	v	v	v	v	v	v	61	62	63	64					
71	Mother																	
	Father																	
	FM '46						vv											
72	Mother																v	
	Father																v	
#	M '51	v	v	v	v	v	v	v	61	62	63	64	65					
	M '53					v		62			65		67					
73	Mother																v	
	Father																v	
	M '46														60			
	F '49			v				v			61		63		60			
#	M '51	v	v	v	v	v	v	v	61	62	63	64	65					
74	Mother																	
	Father																	
	M '49				v			v			61		63					
#	F '50	v	v	v	v	v	v	v	60	61	62	63	64					

FAMILIES TAKING PART IN THE BURLINGTON PROJECT

FAMILY		AGE IN YEARS																
Sex	Birth	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Adult	
<u>H</u> (cont'd)																		
75	Mother																v	
	Father																v	
	M '48									v			63					
	M '49										61		63					
#	M '51	v	v	v	v	v	v	v	61	62	63	64	65					
76	Mother (deceased)																	
	Father																v	
	M '45								v									
	F '49				v						61		63					
#	M '51	v	v	v	v	v	v	60										
77	Mother																	
	Father																	
	F '48				v			v			60		62					
#	M '51	v	v	v	v	v	v	60										
	F '55				61			64			67		69					
78	Mother																	
	Father																	
	FF '46						vv				vv		60					
	M '48				v			v			60							
	F '52						60											
79	Mother																v	
	Father																	
#	F '51	v	v	v	v	v	v	v	61	62	63	64	65					
	F '55					v		62			65		67					
80	Mother																v	
	Father																v	
	FF '54			vv	vv													
	F '55	v		v														
<u>J</u>																		
81	Mother																v	
	Father																v	
	M '47						v					v	61					
#	M '50	v	v	v	v	v	v	v	60	61	62	63	64					

FAMILIES TAKING PART IN THE BURLINGTON PROJECT

FAMILY		AGE IN YEARS																
Sex	Birth	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Adult	
<u>J</u> (cont'd)																		
82	Mother																v	
	Father																v	
#	F '51	v	v	v	v	v	v	v	61	62	63	64	65					
	F '54				v			63			66		68					
83	Mother																v	
	Father																v	
	F '46						v						60					
#	F '50		v	v	v	v	v	v	v	61	62	63	64					
84	Mother																v	
	Father																	
	F '48				v			v			60		62					
#	F '50	v	v	v	v	v	v	v	v	61	62	63	64					
	F '53				v			62			65		67					
85	^K Mother																v	
	Father																v	
	M '43										v							
	F '44									v								
	F '49				v			v			61		63					
#	F '52	v	v	v	v	v	v											
86	Mother																	
	Father																	
	F '43										v							
	F '49				v			v			61		63					
#	M '51	v	v	v	v	v	v	v	61	62	63	64	65					
87	<u>L</u> Mother																	
	Father																	
	M '46											v	61					
	M '49										v	61	63					
#	M '50	v	v	v	v	v	v	v	v	61	62	63	64					
88	Mother																v	
	Father																v	
	M '41																v 19	
	M '42																	
#	M '50		v	v	v	v	v	v	v	61	62	63	64					

FAMILIES TAKING PART IN THE BURLINGTON PROJECT

FAMILY		AGE IN YEARS																
Sex	Birth	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Adult	
<u>L (cont'd)</u>																		
89	Mother																v	
	Father																v	
	F '41										v							
#	F '51	v	v	v	v	v	v	v	61	62	63	64	65					
	F '52						60	61			64		66					
<u>90</u>																		
	Mother																v	
	Father																v	
	F '43										v							
	M '44								v									
#	M '51	v	v	v	v	v	v	60	61	62	63	64	65					
<u>91</u>																		
	Mother																v	
	Father																v	
	F '47						v						61					
#	M '51	v	v	v	v	v	v	v	61	62	63	64	65					
<u>MacD</u>																		
92	Mother																v	
	Father																v	
	M '44								v									
	M '48				v			v			v		62					
#	F '50	v	v	v	v	v	v	v	60	61	62	63	64					
<u>M</u>																		
93	Mother																v	
	Father																v	
	M '48				v			v			v		62					
#	M '49		v	v	v	v	v	v	v	v	61	62	63					
<u>94</u>																		
	Mother																v	
	Father																v	
#	M '50		v	v	v	v	v	v	v	61	62	63	64					
	M '54				60													
<u>95</u>																		
	Mother																v	
	Father																v	
#	M '50		v	v	v	v	v	v	v	61	62	63	64					
#	F '51	v	v	v	v	v	v	v	61	62	63	64	65					
	M '55				61			64			67		69					

FAMILIES TAKING PART IN THE BURLINGTON PROJECT

FAMILY		AGE IN YEARS																
Sex	B irth	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Adult	
<u>M (cont)</u>																		
96	Mother																v	
	Father																v	
	M '46						v						v					
	M '48				v			v			60		62					
#	M '50		v	v	v	v	v	v	v	61	62	63	64					
97 Mother																		
	Father																	
	M '50				v			v			62		64					
#	M '51	v	v	v	v	v	v	60	61	62	63	64	65					
98 Mother																		
	Father																v	
	F '48				v			v			v		62					
#	M '50	v	v	v	v	v	v	v	60	61	62	63	64					
	M '54				v			63			66		68					
<u>Mc</u>																		
99	Mother																	
	Father																	
	F '44								v									
	F '46						v											
	F '47						v						61					
#	M '50		v	v	v	v	v	v	v	61	62	63	64					
#	F '51	v	v	v	v	v	v	60	61	62	63	64	65					
100 Mother																		
	Father																	
	M '49									v	61							
#	M '51	v	v	v	v	v	v	v	61	62	63	64	65					
	M '54				v			63			66		68					
101 Mother																		
	Father																	
#	M '50	v	v	v	v	v	v	v	60	61	62	63	64					
#	M '52	v	v	v	v	v	v	61	62	63	64	65	66					
102 Mother																		
	Father																	
	M '46						v						60					
#	M '51	v	v	v	v	v	v	60	61	62	63	64	65					

FAMILIES TAKING PART IN THE BURLINGTON PROJECT

FAMILY		AGE IN YEARS																
Sex	Birth	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Adult	
<u>Mc</u> (cont)																		
103	Mother																	
	Father																	
	M '42										v							
#	M '59	v	v	v	v	v	v	v	61	62	63	64	65					
103	Mother																	
	Father																	
	M '42										v							
#	M '59	v	v	v	v	v	v	v	61	62	63	64	65					
104	Mother																v	
	Father																v	
	M '50				v			v			62		64					
#	F '51	v	v	v	v	v	v	v	61	62	63	64	65					
105	Mother																	
	Father																	
#	M '50	v	v	v	v	v	v	v	60	61	62	63	64	65				
#	M '51	v	v	v	v	v	v	60	61	62	63	64	65					
<u>N</u>																		
106	Mother																	
	Father																	
#	M '49	v	v	v	v	v	v	v	v	61	62	63	64					
	M '54				v													
107	Mother																	
	Father																	
	M '49				v			v			61		63					
#	F '51	v	v	v	v	v	v	v	61	62	63	64	65					
108	Mother																v	
	Father																	
	M '45								v									
	F '48								v									
#	F '50		vv	v	v	v	v	v	60	61	62	63	64	65				
#F	F '51	vv	vv	vv	vv	vv	vv	60	61	62	63	64	65					

FAMILIES TAKING PART IN THE BURLINGTON PROJECT

<u>FAMILY</u>		<u>AGE IN YEARS</u>																	
Sex	Birth	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Adult		
<u>N (cont)</u>																			
109	Mother																		
	Father																		
	M F '48				vv			vv			vv		62						
<u>O</u>																			
110	Mother																		
	Father																		
#	M '51	v	v	v	v	v	v	v	61	62	63	64	65					v	
	M '52						60	61			64		66						
	M '54				v			63			66		68						
111	Mother																		
	Father																		
#	F '50	v	v	v	v	v	v	v	60	61	62	63	64					v	
	F '54				60			63			66		68					v	
	F '55				61			64			67		69						
<u>P</u>																			
112	Mother																		
	Father																		
	F '46						v												
#	M '50		v	v	v	v	v	v	v	61	62	63	64					v	
113	Mother																		
	Father																		
#	M '51	v	v	v	v	v	v	v										v	
	F '48				v			v			60		62					v	
114	Mother																		
	Father																		
#	F '50		v	v	v	v	v	v	v	61	62	63	64						
	F '52						60	61			64		66						
115	Mother																		
	Father																		
#	M '50	vv	vv	vv	vv	vv	vv	vv	61	62	63	64	65					v	
	M '52		v		61						64		66					v	

FAMILIES TAKING PART IN THE BURLINGTON PROJECT

FAMILY			AGE IN YEARS														
Sex	Birth	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Adult
P (cont'd)																	
116	Mother																v
	Father																v
	M '43										v						
#	M '50	v	v	v	v	v	v	v	v	61	62	63	64				
117 Mother																	
	Father																
	M '47						v								60		
#	M '51	v	v	v	v	v	v	60	61	62	63	64	65				
118 Mother																	
	Father																v
	M '48				v			v			60		62				v
#	F '51	v	v	v	v	v	v	v	61	62	63	64	65				
119 Mother																	
	Father																
	M '48				v			v			60		62				
#	F '51	v	v	v	v	v	v	v	61	62	63	64	65				
120 Mother																	
	Father																
	M '49				v			v			60		62				
#	F '51	v	v	v	v	v	v	60	61	62	63	64	65				
121 Mother																	
	Father																v
	M '45									v							v
#	M '51	v	v	v	v	v	v	v	61	62	63	64	65				
122 Mother																	
	Father																
	M '43										v						
#	F '49		v	v	v	v	v	v	v	60							

FAMILIES TAKING PART IN THE BURLINGTON PROJECT

FAMILY			AGE IN YEARS															
Sex	Birth		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Adult
P(Cont'd)																		
123	Mother																	
	Father																	v
	F	'42										v						
#	M	'51	v	v	v	v	v	v	60	61	62	63	64	65				
124	Mother																	
	Father																	
	M	'49										61		63				
#	M	'51	v	v	v	v	v	v	v	61	62	63	64	65				
	M	'55				61			64			67		69				
125	Mother																	v
	Father																	v
	F	'49				v			v			61		63				
#	M	'51	v	v	v	v	v	v	60	61	62	63	64	65				
126	Mother																	v
	Father																	v
	F	'50	v	v	v	v	v	v	v	60	61	62	63	64				
#	M	'55				61			64			67		69				
127	Mother																	
	Father																	
	F	'43										v						
	F	'45																
#	F	'49		v	v	v	v	v	v	v	60	61	62	63				
	F	'52						60	61			64		66				
128	Mother																	
	Father																	
	M	'46						v										
#	M	'51	v	v	v	v	v	v	60	61	62	63	64	65				
129	Mother																	v
	Father																	v
#	F	'50		vv	v	v	v	v	v	v	61	62	63	64				
#	F	'51	v	v	v	v	v	v	60	61	62	63	64	65				
	F	'53			v				62			65		67				

FAMILIES TAKING PART IN THE BURLINGTON PROJECT

FAMILY		AGE IN YEARS																
Sex	Birth	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Adult	
<u>R</u> (cont'd)																		
130	Mother																v	
	Father																v	
	M '49									60	61		63					
#	M '51	v	v	v	v	v	v	60	61	62	63	64	65					
	F '53							62			65		67					
131	Mother																v	
	Father																v	
	F '48				v			v			60		62					
#	M '51	v	v	v	v	v	v	v			63		65					
132	Mother																	
	Father																	
#	M '51	v	v	v	v	v	v	v	61	62	63	64	65					
#	R '54				v			63			66		68					
133	Mother																	
	Father																	
	M '42										v							
	F '43										v							
	F '46						v											
#	M '50		vv	v	v	v	v	v	v	v	61	62	63	64				
134	Mother																	
	Father																	
	M '42										v							
	M '47						v											
#	M '49		v	v	v	v	v	v	v	60	61	62	63					
#	M '50	v	v	v	v	v	v	v	60	61	62	63	64					
135	Mother																	
	Father																	
	M '45								v									
	M '46						v											
#	M '51	v	v	v	v	v	v	60	61	62	63	64	65					
136	<u>S</u> Mother																v	
	Father																v	
	F '40																v	
	M '41										v							
	F '47						v				v							
#	F '50		v	v	v	v	v	v	v	61	62	63	64					

FAMILIES TAKING PART IN THE BURLINGTON PROJECT

FAMILY		AGE IN YEARS																
Sex	Birth	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Adult	
S (cont)																		
137	Mother																	
	Father																	
	M '46						v											
#	F '51	v	v	v	v	v	v	v	61	62	63	64	65					
	F '54				60			63			66		68					
138	Mother																	
	Father																	
#	F '51	v	v	v	v	v	v	v	61	62	63	64	65					
	'54				60			63			66		68					
139	Mother																	
	Father																	
	F '46						v						60					
#	F '51	v	v	v	v	v	v	v	61	62	63	64	65					
140	Mother																v	
	Father																	
	M '48				v			v			v		62					
#	M '51	v	v	v	v	v	v	v	61	62	63	64	65					
141	Mother																	
	Father																	
	F '47						v						61					
#	F '51	v	v	v	v	v	v	v	61	62	63	64	65					
142	Mother																	
	Father																	
	F '46						v						60					
#	F '50		v	v	v	v	v	v	v	61	62	63	64					
143	Mother																	
	Father																	
	M '45								vv									
144	Mother																	
	Father																	
	M '43										vv							

FAMILIES TAKING PART IN BURLINGTON PROJECT

FAMILY		AGE IN YEARS															
Sex	Birth	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Adult
<u>S</u> (cont)																	
145	Mother																v
	Father																v
#	M '50		vv	v	v	v	v	v	60	61	62	63	64				
	F '53						61	62			65		67				
146	Mother																v
	Father																v
#	F '50		v	v	v	v	v	v	v	61	62	63	64				
	F '52						60	61			64		66				
147	Mother																
	Father																
	M '49				v			v			61		63				
#	M '50	v	v	v	v	v	v	v	60	61	62	63	64				
148	Mother																
	Father																
#F	F '50		vv	vv	vv	vv	vv	vv	vv	61	62	63	64				
<u>T</u>																	
149	Mother																v
	Father																v
	M '46						v						60				
#	F '50		v	v	v	v	v	v	v	61	62	63	64				
#	M '51	v	v	v	v	v	v	v	61	62	63	64	65				
150	Mother																
	Father																
#F	F '50		vv	vv													
151	Mother																
	Father																
	M '47						v										
#	F '50		v	v	v	v	v	v	v	61	62	63	64				
152	Mother																
	Father																
	F '47						v										
#	M '50	v	v	v	v	v	v	v	60	61	62	63	64				
	F '52						60	61			64		66				

FAMILIES TAKING PART IN THE BURLINGTON PROJECT

FAMILY			AGE IN YEARS														
Sex	Birth	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Adult
T (cont'd)																	
153	Mother																v
	Father																v
#	M	'50		v	v	v	v	v	v	61	62	63	64				
#	M	'51	v	v	v	v	v	v	v	61	62	63	64	65			
154 Mother																	
	Father																v
#	F	'50		v	v	v	v	v	v	61	62	63	64				v
	F	'52					60	61			64		66				
155 Mother																	
	Father																
	F	'44							v								
	M	'47					v						60				
#	F	'50		v	v	v	v	v	v	61	62	63	64				
	M	'52					v	61			64		66				
	M	'53					61	62			65		67				
156 Mother																	
	Father																
	F	'43									v						
#	F	'51	v	v	v	v	v	v	61	62	63	64	65				
157 Mother																	
	Father																
	M	'47										60					
#	M	'50	v	v	v	v	v	v	60								
158 Mother																	
	Father																
	F	'48				v		v			v						
#	F	'51	v	v	v	v	v	v	61	62	63	64	65				
V																	
159	Mother																
	Father																
	F	'48				v		v			60						
#	M	'50		v	v	v	v	v	v	61	62	63	64				
	F	'55				61		64			67		69				

FAMILIES TAKING PART IN THE BURLINGTON PROJECT

FAMILY		AGE IN YEARS																
Sex	Birth	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Adult	
V (cont'd)																		
160	Mother																	
	Father																	
M	'44								V									
M F	'48				vv			vv		vv	vv		62					
W																		
161	Mother																	
	Father																	
F F	'46						vv											
# M	'51	V	V															
	Y																	
162	Mother																	
	Father																	
M	'44								V									
M M	'48				vv			vv		vv	vv		62					
163	Mother																V	
	Father																V	
M	'43											V						
M M	'46						vv				vv							
164	Mother																	
	Father																	
M	'44								V									
F	'46						V											
F	'48				V			V				V						
# M	'50	V	V	V	V	V	V	V	V		61	62	63	64				
165	Mother																	
	Father																	
F	'46						V											
# M	'50	V	V	V	V	V	V	V	V		61	62	63	64				
166	Mother																V	
	Father																V	
F	'49				V			V				61						
# F	'51	V	V	V	V	V	V	V	61	62	63	64	65					
F	'52						60	61			64		66					
F	'55				61			64			67		69					
167	Mother																	
	Father																	
F	'42											V						
M F	'46				vv			vv			vv		62					

FAMILIES TAKING PART IN THE BURLINGTON PROJECT

FAMILY		AGE IN YEARS																
Sex	Birth	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Adult	
<u>W</u> (cont'd)																		
168	Mother																v	
	Father																v	
# F	'49		v	v	v	v	v	v	v	61	62	63	64					
M	'52						v	61			64		66					
169	Mother																	
	Father																	
# F	'50	v	v	v	v	v	v	v	60	61	62	63	64					
M	'53					v		62			65		67					
170	Mother																v	
	Father																v	
# M	'50		v	v	v	v	v	v	v	61	62	63	64					
# M	'51	v	v	v	v	v	v	60	61	62	63	64	65					
171	Mother																	
	Father																v	
M	'44								v						v			
F	'47						v											
M	'49				v			v			61		63					
# F	'51	v	v	v	v	v	v	v	61	62	63	64	65					
172	Mother																	
	Father																	
F	'46						v											
# F	'51	v	v	v	v	v	v	v	61	62	63	64	65					
F	'52						60	61			64		66					
F	'54				60			63			66		68					
173	Mother																	
	Father																	
M	'49				v			v			61		63					
# F	'51	v	v	v	v	v	v	v	61	62	63	64	65					
M	'53					60		62			65		67					
174	Mother																	
	Father																	
F	'49								v		61		63					
# M M	'51		vv	vv	vv	vv	vv	vv	61	62	63	64	65					

TABLE V

A Summary of Tracings & Measurements included in the Burlington Files on Families #

Investigator: Hatton

CASES	Age (Yrs) & Sex	TRACINGS				MEASUREMENTS of CHARACTERISTICS										CHARACTERISTICS	
		LATERALS	OBLIQUES, duplicates				1	2	3	4	5	6	7	8	9	10	
			Rt.	Lt.	Rt.	Lt.											1. Mandibular Length
Parents																	2. Gonial Angle
Mother		15	14	14			14	14	-	-	-	-	15	15	15	15	3. Height of $\frac{6}{6}$ 6
Father		12	11	11			11	11	-	-	-	-	12	12	12	12	above inferior border of the mandible
Offspring	3	8	71	71	26	25	-	-	30	30	30	30	-	-	-	-	4. Mesio-distal width of $\frac{6}{6}$
		3	104	104	10	10	-	-	76	76	76	76	-	-	-	-	
	4	55	53	53			-	-	30	30	30	30	-	-	-	-	5. Height of $\frac{e}{e}$ above the inferior border of the mandible
		68	112	112			-	-	76	76	76	76	-	-	-	-	6. Distance between mesial border of $\frac{6}{6}$ and distal border of $\frac{3}{3}$
	5	22	43	43			-	-	30	30	30	30	-	-	-	-	
		4	100	100			-	-	76	76	76	76	-	-	-	-	
	6	19	35	35			19	19	6	6	6	6	19	19	19	19	7. Cranio-facial index
		19	116	116			19	19	76	76	76	76	19	19	19	19	8. Facial Angle
	7	5	5	5			-	-	-	-	-	-	-	-	-	-	9. A - B Relation
		4	7	7			-	-	-	-	-	-	-	-	-	-	10. Cranio- occlusal angle.
	8	5	5	5			-	-	-	-	-	-	-	-	-	-	
		2	6	6			-	-	-	-	-	-	-	-	-	-	
	9	11	12	12			11	11	-	-	-	-	11	11	11	11	
		11	14	14			11	11	-	-	-	-	11	11	11	11	

Sections of this material have already been utilized in these papers, viz:

1. The Relation between Intra-Alveolar and Clinical Eruption
2. Some Characteristics of Eruption in Neutroclusion and Class II Cases.
3. Hereditary Factors in Cranio-Facial Development: A Preliminary Study.

INTER-RELATIONS OF MALOCCLUSION MANIFESTATIONS AND ETIOLOGIC FACTORS

This report was prepared by R. M. Grainger.

This is a preliminary report on the prevalence and inter-relations of the various clinical manifestations and etiologic factors tabulated in Table II of Progress Report No. 3, 1957-58. The basically mathematical epidemiological method contributes a degree of objectivity not achievable when merely drawing on memory of clinical experience. This objectivity combined with broad (but recognized as still incomplete) coverage of items provides a sort of aerial map of the field and it is hoped easy means of access to facts for the student of orthodontics.

The mathematical approach is far from infallible and becomes very cumbersome as the number of factors being considered at any one time rises above two, or three. While in the end, knowledge of the physiology, anatomy, embryology, etc. are the final means of understanding malocclusion, mathematical checking of clinically derived concepts is very valuable. Conversely, mathematically suggested syndromes may throw considerable light on some still unsolved clinical problems.

FINDINGS AND ANALYSIS METHOD

The findings are given in tables I and II.

The purposes of statistical analysis in this study are to determine, (1) if difference in prevalence rates of the various manifestations which occur by age, antero-posterior denture relation, or skeletal relation are greater than might be commonly expected by random sampling variation, table I, (2) if there exists a significant degree of correlation between the various manifestations of malocclusion, i.e. if certain characteristics tend to occur jointly in the same individual, or conversely, if certain attributes tend to occur only in the absence of other specified attributes, and (3) if the tendency for joint occurrence varies according to the presence or absence of specified third factors. These will be discussed in the order mentioned.

Significance of Differences. Differences between prevalence rates (percentages) in table I were assessed by the normal-deviate test which is appropriate for large samples. Specifically, the formula for testing the differences between percentage is:

$$Z = \frac{P_1 - P_2}{\sqrt{\frac{P_1(1-P_1)}{N_1} + \frac{P_2(1-P_2)}{N_2}}}$$

where P equals percentage, and N the sample size for each group respectively. A Z value of 2 or more was considered significant. Frequently, in testing differences with age, the 3 and 6 year groups were combined and tested against the 10 and 12 year groups combined, with the idea of quickly establishing that an obvious trend was beyond chance. As an illustration, the decrease in neutroccclusion cases with age was tested by this method as follows:

<u>Age</u>	<u>P</u>	<u>N</u>	<u>NP</u>	<u>Age</u>	<u>P</u>	<u>N</u>	<u>NP</u>
3	74.6	268	19992.8	10	72.5	207	15007.5
6	81.3	<u>291</u>	<u>23658.3</u>	12	68.2	<u>217</u>	<u>14799.4</u>
Total		559	43651.1	Total		424	29806.9

P for 3 and 6 combined is

and for 10 and 12 combined is

$$\frac{43651.1}{559} = 78.09$$

$$\frac{29806.9}{424} = 70.30$$

$$Z = \frac{78.09 - 70.30}{\sqrt{\frac{78.09 \times 21.91}{559} + \frac{70.30 \times 29.70}{424}}} = \frac{8.79}{2.83} = 3.11$$

This value being greater than 2 is taken as evidence that the trend with age is not due to random sampling variation. The presence of differences beyond chance in table I is designated by a system of symbols explained in the footnote to that table.

Correlations. Table II is a multiple abridged contingency table. Theoretically, if the prevalence rates for the various attributes as given in Table I were exact (i.e. based on samples of many thousands of observations), the expected number of times two attributes would occur jointly would be exactly given as the product of the two percentages each divided by 100, multiplied by the number of persons examined. For example, the prevalence rates for items P2 and P4 among the children with neutroccclusion are given in Table I as 6.0% and 14.6% respectively. The expected

number of joint occurrences in a sample of 892 (if the two characteristics are not correlated) is computed to be .06 times .146 times 892, which equals 7.8. This value is slightly more accurately computed, 7.9, when the percentages are not rounded off and is given in the 5th row and 4th column of Table II. In the same cell of Table II, directly above this theoretically expected value, is the number of times the joint occurrence did occur, here 15. If the number of joint occurrences observed is substantially greater than the expected value, we conclude that the items are dependent or correlated. If the number of actual joint occurrences is substantially lower than the expected, we conclude that the items are indirectly correlated, i.e. the presence of one attribute works against the other occurring. If the number of joint occurrences is very similar to the expected value, we have no evidence of lack of independence, or correlation between the attributes.

Those familiar with analysis of 2x2 contingency tables will recognize that these values are the observed and expected frequencies from one of the four cells of the full table. For the case illustrated, the expanded table which may be built up using the frequencies in Table I is as follows:

Item P2	Item P4		P2 Totals
	Present	Absent	
Present	o 15 e 7.9	o 39 e 46.1	54
Absent	o 115 e 122.1	o 723 e 715.9	838
P4 Totals	130	762	892

where the expected and observed values for the other cells are obtained from the marginal totals by subtraction.

The conventional method of testing significance in this table is to compute χ^2 equal $(o - e)^2 / e$ as follows:

number of joint occurrences in a sample of 892 (cf. the two characterizations are not correlated) is compared to be 1.00 times. This gives 892, which again 7.9. When the percentages are if more accurately computed 7.9, when the percentages are not rounded off and is given in the 5th row and 4th column of Table II. In the same cell of Table II, directly above this theoretically expected value, is the number of times the joint occurrence did occur, here 15. If the number of joint occurrences observed is substantially greater than the expected value, we conclude that the items are dependent on correlated. If the number of actual joint occurrences is substantially lower than the expected, we conclude that the items are statistically correlated, i.e., the presence of one attribute works against the other occurrence. If the number of joint occurrences is very similar to the expected value, we have no evidence of lack of independence, an correlation between the attributes.

These familiar with analysis of 2x2 contingency tables will recognize that these values are the observed and expected frequencies from one of the four cells of the table. For the case illustrated, the expected table which may be built up using the frequencies in Table I is as follows:

Item P1			
Item P2	Present	Absent	P2 Totals
Present	15 0 7.9	0 38 0 10.1	53
Absent	0 15 0 132.1	0 723 0 715.9	838
P2 Totals	15	761	892

where the expected and observed values for the other cells are obtained from the marginal totals by subtraction.

The conventional method of testing significance in this table is to compute χ^2 equal to $\sum \frac{(O-E)^2}{E}$ as follows:

Upper left cell	=	$(15 - 8.4)^2 / 7.9$	=	5.514
Upper right cell	=	$(39 - 45.6)^2 / 46.1$	=	0.945
Lower left cell	=	$(115 - 121.6)^2 / 122.1$	=	0.357
Lower right cell	=	$(723 - 716.4)^2 / 715.9$	=	<u>0.061</u>
Total				6.877

To be considered beyond chance, the χ^2 should exceed 3.841. It will be observed that the major component is derived from the upper left cell in this situation and it is these values which are given in Table II. For rapid screening of the more than 800 relationships in Table II this approximation was considered quite adequate. However, those interested may easily construct the proper 2 x 2 table in any case and apply the exact binomial solution² or the more elaborate Chi-square analysis with correction for asymmetry³. The nature of the significant correlations found in Table II is indicated by signs +, ++, -, and = which mean that the correlation is positive, strongly positive, negative, and strongly negative respectively. Negative correlation means that as one factor increases the other tends to decrease, not that the relation is zero.

The correlations for the total sample (neutroocclusion, distocclusion and mesiocclusion) may be tested by adding the three observed values and testing against the sum of the three expected values. In some cases where only a weak relation exists, it has been detectable in the combined group and not in any of the three separate groups. An example of this occurs in the relationship between P1 and P5. Here a negative correlation is suggested in all occlusion types by the values 0:2.2, 0:1.4, and 0:0.8. Analysis of the combined set gives a χ^2 value which suggests a significant negative correlation:

$$[\chi^2] = [(0 - |4.4 - .5|)^2 / 4.4] = 3.5$$

Interactions. The presence of interaction between the correlations of Table II according to the types of antero-posterior denture relationship was recorded when combining the three groups reduced or eliminated the correlation which had been established for one of the single groups. As an illustration, there is a strong positive correlation between P3 and P5 for the neutroocclusion cases but not for the distocclusion or mesiocclusion cases. Analysis of the combined set of 161 observed joint occurrences against a theoretically

expected total of 140.3 cases gives a χ^2 component equal $(161 - 140.8)^2 / 140.3$ which works out to 2.91. If the relation between P3 and P5 had been similar for all three cases, combining the data would have produced a higher χ^2 value than that for the neutroccclusion cases alone. The marked reduction in the value of the χ^2 is therefore evidence that the relation between P3 and P5 differs in neutroccclusion as against distocccclusion cases. This pooling procedure is crude and relatively insensitive, compared to the correct method of testing for second degree interaction⁵, but it does give some clinical insight while avoiding the lengthy, more elaborate computations. A great body of such interactions arising from the influence of each of the items on each possible pair remains to be considered. We are not reporting on these at this time for the simple reason that some 24,000 such tests present themselves for consideration. It needs to be stressed that the simple relationships tabulated in Table II do not necessarily portray the true clinical picture because the third or fourth factor interactions may be vitally important. One example of the changing relationships between P2, P3, and P4 when one factor is absent will be discussed later.

Lastly, it needs to be made clear that, when any large number of samplings or statistical tests are carried out, some very rare and atypical results are bound to occur. Hence, one should accept as valid no results which just do not make sense clinically.

DISCUSSION

The crude total prevalence rates given in the first column of Table I are of interest for various reasons. First, in examination of our criteria which were supposed to represent clinically important deviations from the population norms, it might be argued that the definition for overjet (P3) was not sufficiently severe because the rate of 39% abnormal is rather high. On the other hand, some of the estimates, e.g. prevalence of congenitally missing teeth (T6), or ectopic eruption (T8) may seem surprisingly low to a group of practising pedodontists. This is because such defects are not nearly as frequent in the population at large as in the patients that general practitioners refer to the specialists. The relative frequency of such defects as premature loss of primary teeth (T1) or mid-line diastema (P9) are misleading in terms of the total group (all ages) because they tend to manifest their true peak only at specific ages. The true peak for T1 is shown at ages 8 to 10 years and the true prevalence of pathologic diastema cannot be seen until around age 12 when the lateral incisors and cuspids have completely erupted.

The frequency of the various manifestations is some guide to the amount of time which should be devoted to them in a teaching schedule or in public health programs. It seems sometimes that an inordinate amount of attention is given to very rare defects such as supernumerary teeth while neglecting practical consideration of more common defects like simple malposition of individual teeth where not lack of space complicates the treatment (P10).

Changes in prevalence of the various attributes with age may often take the form of gradual trends upward, or downward as seen in the cases of non-active and active sucking habits (E6 and E6a). In some instances these gradual trends may be false due to definition bias at certain ages. For example, the number of cases with excessive overjet (P3) is biased downward at age six when the incisors are not available for observation. Also, at age three years we are dealing with primary teeth which may or may not be comparable to permanent teeth in regard to overjets. Thus, the superficial trend is not necessarily clinically correct unless we can be sure that the observational units are exactly comparable. In the case of P4, there is sufficient evidence in the 8, 10, and 12 year figures to conclude that the trend is downward. But, for P3, no clear trend is seen for these older ages and it cannot be established that the prevalence of excessive overjet changes with age.

The prevalence of mid-line diastema (P9) starts low, then increases, only to fall again in the older ages confirming the observation that most of the mid-line diastema disappears of its own accord. Other factors are of interest because they are quite constant or increase only slightly, thus documenting that they are not self correcting. Examples are the prevalence of posterior crossbites (P2 and P2b).

Age changes in the tendency toward acute occlusal plane to cranial base angle, and in 'B' point to 'A plane' relation suggest that age specific averages rather than total group averages should be used in defining these characteristics if we are to avoid the conclusion that over ten per cent of the skeletal relationships are pathologically mesial by age 12.

Finally, there are some cases which appear to be so irregular and so unexpected clinically that they are only explainable as gross classification errors or sampling artifacts. A rather obvious example is the rate for E9 at age 8 years.

Prevalence differences according to antero-posterior dental and skeletal relations are also shown in Table I. Unfortunately, the number of mesiocclusion cases in this population is very limited and thus, these prevalence rates and correlations are far less reliable than those for the other two occlusion types. Some confirmation may be obtained in the mesiocclusion results by checking with the slightly larger sample comparisons in the skeletal-base column. In general, the tendency toward mesial or to distal antero-posterior relation is higher in the skeletal comparison than the dental column suggesting that these defects arise more from basal bone disharmony than vice versa, and that the locking effect of the cusps is to resist the dental defect following the underlying trend.

Setting aside the absolute prevalence rates, it is interesting to list the manifestations and etiological factors which are significantly higher or lower in three antero-posterior denture relation types. These are also shown graphically in figure 2.

Distocclusion cases are distinguished by having:

1. The highest maxilla to buccal posterior crossbite rates (P2b),
2. The highest incisal overjets of both types (P3,P4),
3. The highest prevalence of deep overbite (P5),
4. The highest prevalence of crowding, particularly in the upper permanent arch (P11),
5. The highest prevalence of narrow high palates (E1),
6. The highest prevalence of both active and non-active sucking habits (E6a,E6),
7. The greatest tendency toward acute occlusal plane to cranial-base-angle (E8).

Neutrocclusion cases are distinguished by having:

1. The highest prevalence of mid-line diastema (P9),
2. The lowest prevalence of crowding of upper permanent teeth (P11),
3. The highest prevalence of simple malposition of teeth where space is available for correction (P10),
4. The lowest prevalence of macrodontia (T6),
5. A low prevalence of non-active sucking habits (E6),
6. The greatest tendency toward obtuseness of the occlusal plane to cranial-base-angle (E9).

Mesiocclusion cases are distinguished by having:

1. The highest prevalence of multiple anterior crossbite (P1),
2. The highest prevalence of posterior crossbite with the maxilla to the lingual (P2),

3. The lowest prevalence of incisal overjet of both types (P3,P4),
4. The lowest prevalence of deep overbite (P5),
5. The highest prevalence of open contacts in both arches (P7,P8),
6. The lowest prevalence of simple malposition of teeth with no lack of space for correction (P10),
7. The highest prevalence of loss of permanent teeth (T2),
8. The highest (probably) prevalence of macrodontia (T6),
9. The lowest prevalence of active and non-active sucking habits (E6,E6a).

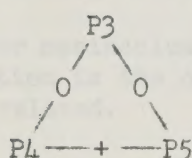
Inter-relations between malocclusion manifestations,
Table II. The whole listing of multiple occurrences of the characteristics under study has been published in the third of the series of Burlington Project Reports, and also in the Transactions of the Workshop on Public Health Significance of Malocclusion held at Michigan, 1958⁴. Considering that few of the rates given in Table I are as high as ten per cent, and that many are in the order of two per cent or less, the probability of finding many joint occurrences in a sample of one thousand would be quite low unless the characteristics were fairly strongly correlated. Since that general pattern is toward multiple occurrence of the attributes in the same individual, we can safely conclude there is a wide underlying correlation among the defects. Our ultimate objective then, is to identify the groups of factors which most frequently occur jointly; hence, should be clinically recognized as syndromes. Superimposed on any pattern of multiple occurrences of symptoms in an individual, we can expect on occasions to find second, or third syndromes. And to make matters worse for the clinician, we will also find a fair sprinkling of rare but inevitable chance occurrences of unrelated factors. All this adds up to great confusion clinically when one tries to decide which factors are the most important in any situation, and the mathematical approach is perhaps the only way of sorting things out. In the end, however, each syndrome which may be mathematically suggested, must be verified through anatomical and physiological understanding of the pathologic process.

As to the interpretation of Table II, factors which are related in a cause and effect manner are correlated but all correlated factors do not have a cause and effect relationship. Correlations between factors may be observed because they are mutually related to a third factor. Among the commonest of these false correlations are those associated with time. The possibility exists that some of the correlations in Table II are due to the fact that either both factors are increasing or one is increasing and the other

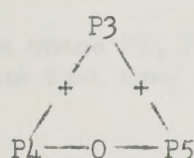
decreasing with time. This can be checked by confirming the correlations on an age specific basis. Examination of a few examples leads us to think that this type of error is negligible in Table II. Another point relates to the sensitivity of analysis of data (such as these which are fundamentally measurement data) as if they were qualitative data. For example we have arbitrarily stated that crowding is present when three or more millimeters of space would be required to effect correction. It might be that the whole process would be physiologically more meaningful if we had set the limit at two and a half or three and a half millimeters. The result of an arbitrary recording level is to sometimes fail to detect relationships which are indeed important. Therefore when no correlation has been detected in Table II we should accept this literally rather than make the inference that no relationship exists. On the other extreme we must be on guard against spurious significant correlations which must be expected occasionally due to chance because our criterion for significance is that the correlation is so strong that it would only occur about once in twenty times due to chance when the true relationship was zero.

Merely because two or more manifestations of malocclusion are more prevalent in (for example distocclusion cases) does not mean that they are necessarily correlated or are a part of what might be considered the same syndrome. A most interesting illustration is the relation between the two types of overjet (P3, P4) and deep overbite (P5). These are all most prevalent in distocclusion cases, next prevalent in neutroclclusion cases, and lowest in mesiocclusion cases. Arrayed according to antero-posterior relation the relationships as given in Table II are;

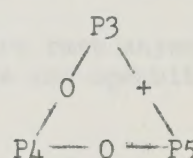
Distocclusion



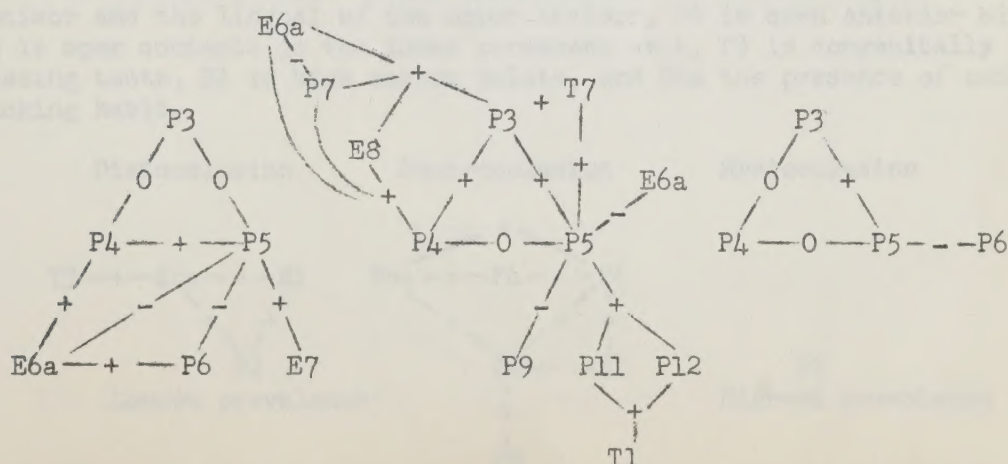
Neutroclclusion



Mesiocclusion



If the associated correlations are fixed to the corners of the triangles the reasons for these different syndromes become much clearer;



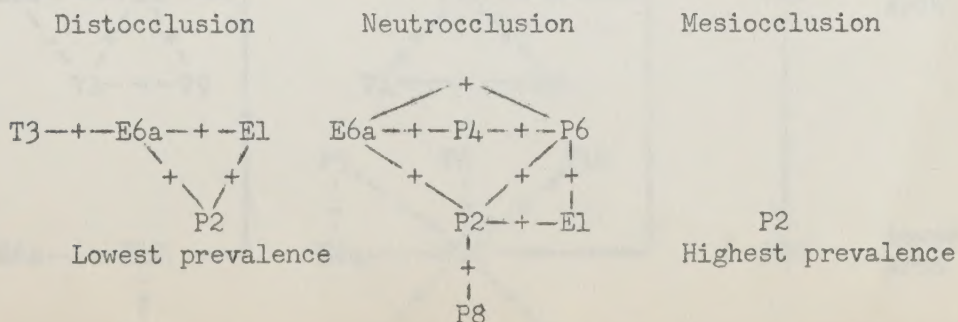
where P6 means openbite, P7 open contacts in upper arch, P9 diastema, P11 and P12 crowding in upper and lower arches respectively, T1 premature loss of primary teeth, T7 over-retention of primary teeth, E6a active sucking habit, and E8 acute occlusal plane angle.

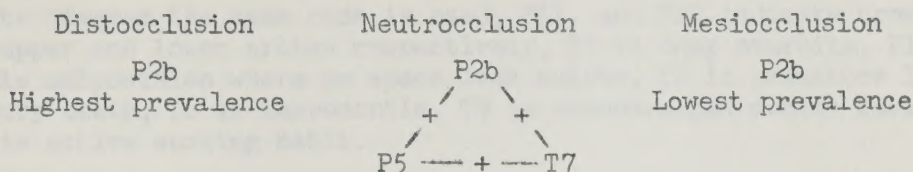
In the distocclusion cases the sucking habit (E6a) is associated with an open lower incisor tip to upper incisor lingual contact (P4), and negatively related to deep overbite (P5). The active habit is correlated to openbite (P6) which is of course the opposite of an overbite (P5). The deep overbite is positively related to facial asymmetry (E7) but the latter is independent of the other factors.

In the neutroclusion cases there seems to be a strong connection between the two forms of overjet (P3, P4), open contacts in the upper arch (P7), active sucking habit (E6a), and tendency toward an acute occlusal plane angle (E8). However, E8, is not correlated to either, E6a, or to, P7, while, E6a, and, P7, are negatively correlated suggesting that three separate sets of circumstances are associated with joint occurrence of the two forms of overjet. A second system seems to operate in connection with deep overbite (P5) which occurs in connection with upper incisor overjet (P3) but not with open lower incisor to upper lingual contact (P4) nor in the presence of sucking habit (E6a). P5, is present when there is crowding of both upper and lower arches (P11, P12) and these are both related to early loss of primary teeth (T1). Naturally following would be the absence of mid-line diastema (P9). Overlong retention or submersion of primary teeth (P7) is positively related to the joint occurrence of, P3, and, P4, but not to either the crowding, or to the sucking habit, (E6a), and hence may be part of a third syndrome.

For mesiocclusion cases where P3, P4, P5 are rare anyway, the only correlation is the obvious one that deep overbite and openbite are negatively related.

A second study of some interest is the array of factors correlated to the two types of posterior crossbite. These are given below where P2 and P2b indicate posterior crossbite with maxilla to the lingual, and to the buccal respectively. P4 is open contact between the tip of the lower incisor and the lingual of the upper incisor, P6 is open anterior bite, P8 is open contacts in the lower permanent arch, T3 is congenitally missing teeth, E1 is high narrow palate, and E6a the presence of active sucking habit.

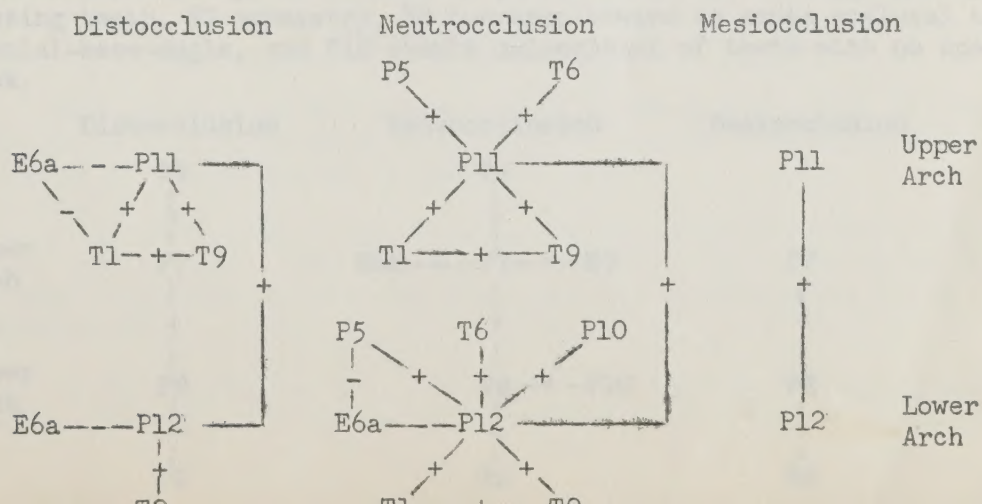




The occurrence of posterior crossbite with the maxilla to the lingual (P2) is highest in mesiocclusion cases (Table I) presumably simply due to denture relation which brings the wider posterior section of the lower arch in apposition to the narrower part of the upper arch. However this type of crossbite is also quite prevalent in neutrocclusion cases having active sucking habit (E6a), open lower incisor to upper lingual incisor contact (P4), open anterior bite (P6), and high narrow palate in the upper arch (E1). This pattern is commonly recognized as the effect of the sucking habit and probably mouth breathing which is unfortunately not recorded in this study. The joint occurrence of the crossbite with open contacts in the lower arch (P8), also seems to be natural enough but this defect does not occur in conjunction with the syndrome described above. The presence of this type of crossbite is sometimes found in distocclusion cases but is there related to active sucking habits (E6a), high narrow palate (E1), and the congenital absence of permanent teeth (T3), which all add up to severe collapse of the upper arch more than compensating for the adverse antero-posterior denture relation.

The posterior crossbite with the maxilla to the buccal is highest in the distocclusion cases, again presumably due to the antero-posterior denture relation, and no doubt for the same reason is extremely rare in mesiocclusion cases. When this type of crossbite occurs in neutrocclusion cases it is associated with early loss of deciduous teeth (T1) and deep overbite (P5), which suggests collapse of the lower arch.

A third study shows the factors relating to crowding of teeth where over three millimeters of space would need to be obtained to correct the deformity. Crowding to this extent is most rarely found in the neutrocclusion cases.



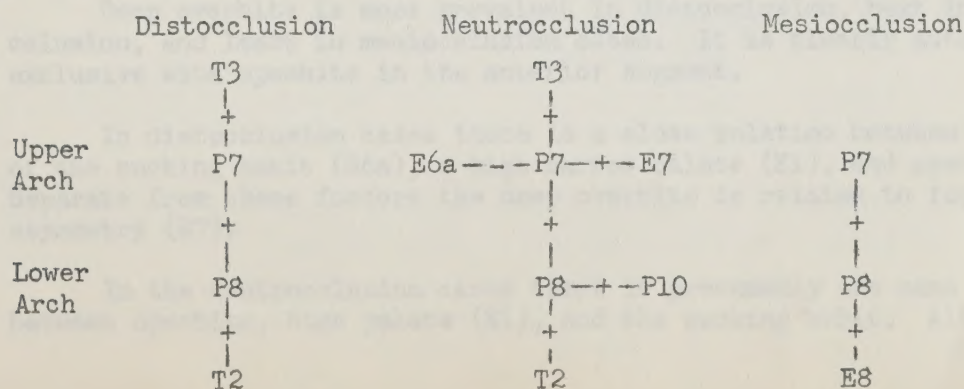
In the diagram the same code is used; P11, and P12 indicate crowding in the upper and lower arches respectively, P5 is deep overbite, P10 is simple malposition where no space lack exists, T1 is premature loss of primary teeth, T6 is macrodontia, T9 is uncontrolled dental caries, and E6a is active sucking habit.

Although, as was stated, crowding is significantly lower in neutro-occlusion cases in the upper arch, there is no great difference in crowding prevalence in the lower arch among the occlusion types. Also crowding is highly correlated in the upper and lower arches. These facts suggest that crowding is caused by some factor that effects the dentition as a whole regardless of antero-posterior denture relation or presence of other positional defects. Crowding occurs in the absence of active sucking habits (E6a) but is positively related to premature loss of deciduous teeth (T1), and naturally enough to uncontrolled dental caries (T9). Crowding in the upper arch tends to be associated with facial asymmetry (E7) in the neutroocclusion cases but not in the distocclusion cases. A possible explanation is that crowding in distocclusion cases is most often related to collapse from lip pressure on the upper anterior section of the arch. It is curious to note the negative relation suggested between uncontrolled caries and the sucking habit. This is confirmed in a table relating tooth defects to etiologic factors that is not included in this paper.

None of the recorded factors seem to be related to crowding of the mesiocclusion cases and it is repeated that some general factors such as skeletal size may be all important in these cases.

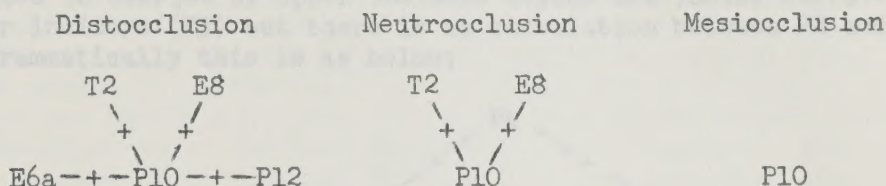
Only those factors joined by a line indicating their correlation tend to occur jointly, thus in the diagram items, P5, and, T6, do not form part of the same system of events as, T1, and, T9.

Open contacts are more prevalent in mesiocclusion cases and the presence of open contacts is of course mutually exclusive with crowding. The factors related to spacing of teeth are few and the pattern is given below where, P7, and P8 indicate open contacts in the upper and lower arches respectively, T2 is loss of permanent teeth, T3 congenitally missing teeth, E7 asymmetry, E8 tendency toward an acute occlusal to cranial-base-angle, and P10 simple malposition of teeth with no space-lack.

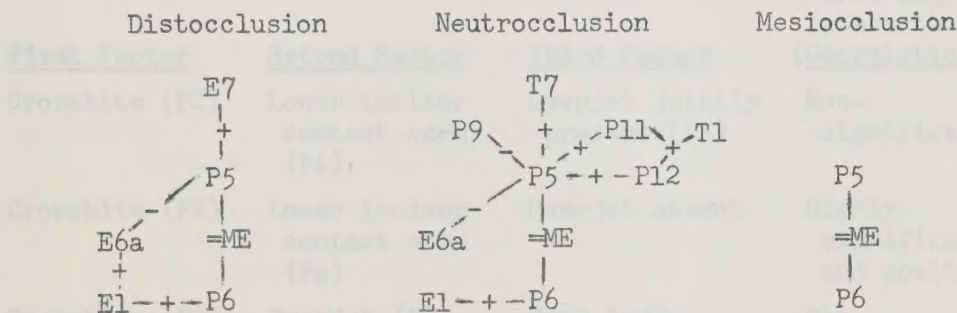


In the upper arch, both for neutroccclusion and distocclusion cases, open contacts are related to congenital absence of teeth (T3) and in neutroccclusion cases alone to facial asymmetry (E7) and to the absence of the sucking habit (E6a). In the lower arch the spacing is found jointly with early loss of primary teeth (T1) in the neutroccclusion and distocclusion cases, but in mesiocclusion cases it is related to acuteness of occlusal plane (E8). In neutroccclusion there is an obvious high frequency of joint occurrences of simple malposition of individual teeth when spacing is present (P10).

Expanding on the occurrence of simple malposition of teeth (P10) we find in distocclusion cases the following array of factors none of which are mutually related. P12 indicates crowding in the lower arch and presumably the simple malposition must be in the opposite arch in these instances.



Openbite, overbite relationships are portrayed in the next diagram below, where P5 is deep overbite, P6 is open anterior bite, P9 is mid-line diastema, P11 and P12 are crowding in the permanent arches, T1 is early loss of primary teeth, T7 over-retention or submersion of primary teeth, E1 high narrow palate, and E6a the sucking habit.



Deep overbite is most prevalent in distocclusion, next in neutroccclusion, and least in mesiocclusion cases. It is clearly mutually exclusive with openbite in the anterior segment.

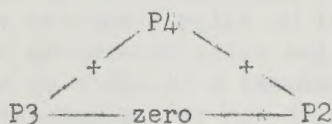
In distocclusion cases there is a close relation between presence of the sucking habit (E6a), a high narrow palate (E1), and openbite (P6). Separate from these factors the deep overbite is related to facial asymmetry (E7).

In the neutroccclusion cases there is presumably the same relation between openbite, high palate (E1), and the sucking habit. Although here

the relation between the habit and the palate shape is not beyond chance. The relation between submersion of deciduous teeth (T7) and crowding has already been commented upon in the first example. Once again, possibly due to the smallness of the sample, no positional relationships are recorded for the mesiocclusion cases.

Effects of third factors on the correlations of Table II. The information in Table II is probably correct for the strong relationships but the following example shows how more subtle correlations may be masked by the overall pooling of data without regard to third factor influences (or second degree interactions as they are called).

In neutrocclusion cases, Table II indicates that posterior crossbite with maxilla to the lingual (P2) is correlated to the presence of open lower incisor to upper lingual incisor contacts (P4). P4, is in turn related to overjet of upper incisors beyond the labial surface of the lower incisors (P3) but there is no correlation between P2 and P3. Diagrammatically this is as below;



The correlation between each of the pairs may now be examined according to whether the third factor is present or is absent. The results and meaning of the second degree interactions may be seen in the following array.

<u>First Factor</u>	<u>Second Factor</u>	<u>Third Factor</u>	<u>First Degree Interaction (Correlation)</u>	<u>Second Degree Interaction</u>	<u>Action</u>
Crossbite (P2)	Lower incisor contact open (P4)	Overjet jointly present (P3)	Non-significant	} Sign.	
Crossbite (P2)	Lower incisor contact open (P4)	Overjet absent	Highly significant and positive		
Crossbite (P2)	Overjet (P3)	Open lower incisor Contact jointly present (P4)	Non-significant	} Sign.	
Crossbite (P2)	Overjet (P3)	Closed incisor lingual contact	Highly significant and positive		
Overjet (P3)	Lower incisor contact open (P4)	Crossbite jointly present (P2)	Significant positive	} Sign.	
Overjet (P3)	Lower incisor contact open (P4)	Crossbite absent	Highly significant and positive		

Thus overjet (P3) occurs jointly with crossbite (P2) but only when the lower incisor contacts the upper lingual surface of the upper incisor. The lower incisor contact to upper lingual incisor is open when crossbite is present but mainly when overjet is normal. When there is no crossbite, open lower incisor contact (P4) occurs jointly with overjet (P3) most frequently.

Each of these situations must represent a specific variation of malocclusion etiologically and clinically. The subtle difference would have been missed if the pooled data had not been separated out.

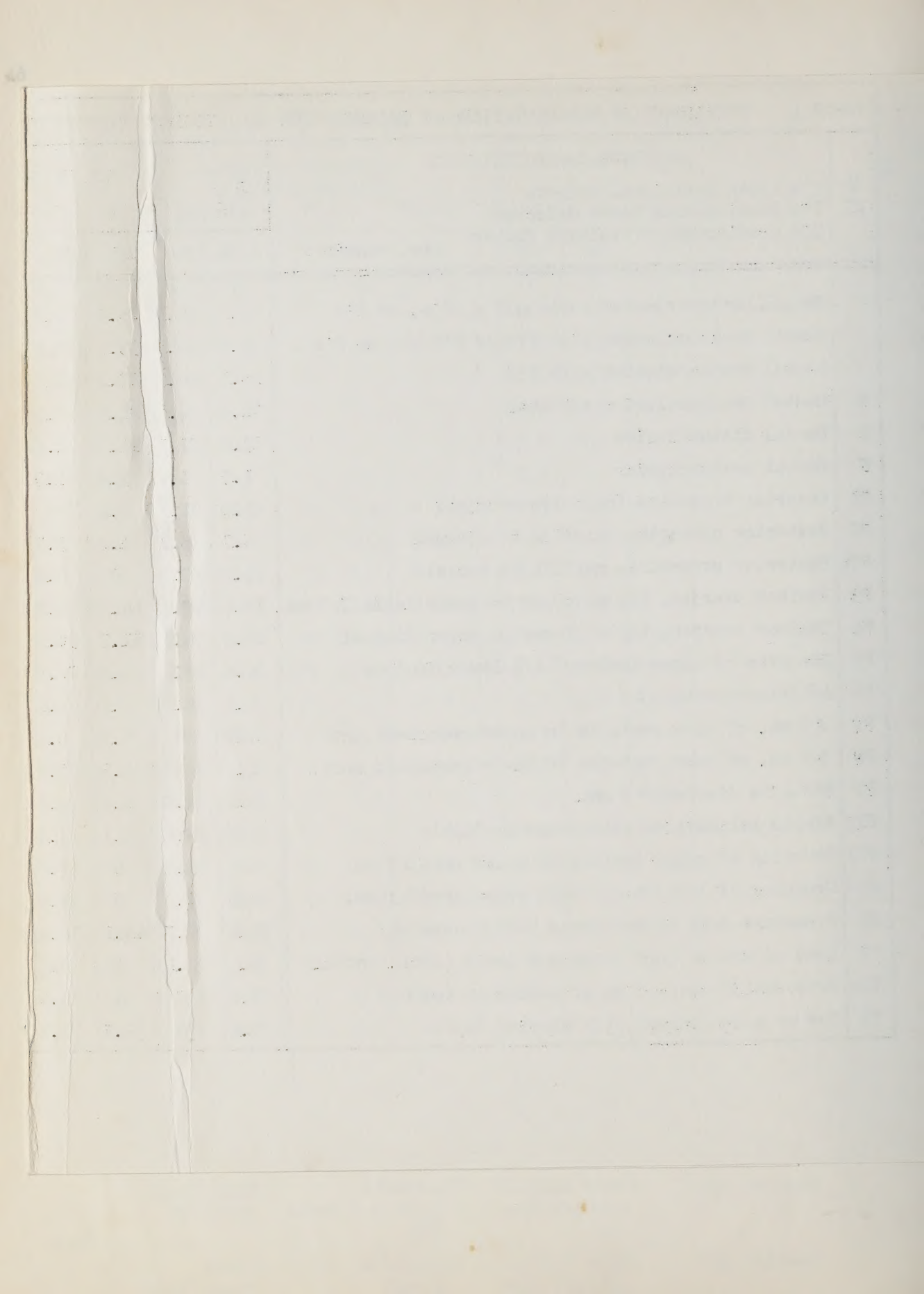
A final comment, it is felt in general that the precision of the definitions is satisfactory for the isolation of most of the important relationships. The most serious defect of the study is the absence of some important clinical manifestations and etiological factors. Among those lacking are, a classification of facial type, and measure of facial size particularly in relation to the crowding and open contact syndromes. Others would be, measures of incisal angles to occlusal plane, posterior tooth angles to median plane of the skull, and the relation of maxilla and of the mandible to some reference point on the cranial base by which to establish their absolute antero-posterior relation. Some work has been done on this latter problem in terms of a template developed at the Burlington Study and already adopted for use in other centres. Lastly, it is not inferred that the classification scheme here presented is the only way of grouping the data and a second method emphasizing etiology rather than symptoms is being seriously studied at the Burlington Orthodontic Research Centre.

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TABLE I PREVALENCE OF MANIFESTATIONS OF MALOCCLUSION AND ETIOLOGIC FACTORS BY AGE, ANTERO-POSTERIOR DENTAL RELATION, AND SKELETAL BASE RELATION

Item	OBSERVED CHARACTERISTICS	Total Group	AGE IN YRS						Sign.	ANTERO-POSTERIOR DENTAL RELATION						B POINT TO A PLANE			
			3	6	8	10	12	Neutro.		Disto.	Mesio.	Sign.	Norm.	Dist.	Mes.	Sign.			
P's tooth positional defects	T's predisposing tooth defects	E's predisposing etiologic factors	no. examined	1194	268	291	211	207	217	892	275	27	828	288	78				
			%	%	%	%	%	%	%	n	%	n	%	n	%	%	%	%	%
	Dental neutroccclusion with no P's, T's, or E's		13.7	23.5	25.0	4.7	3.4	5.1	S	-	-	-	-	-	-	19.8	-	-	-
	Dental neutroccclusion with T's or E's but no P's		15.7	10.4	33.3	17.1	8.7	6.0	S	-	-	-	-	-	-	17.6	9.4	19.2	..
	Dental neutroccclusion with P's		45.1	40.7	23.0	51.7	60.4	57.1	S	-	-	-	-	-	-	48.2	32.9	56.4	..
N	Dental neutroccclusion subtotal		74.5	74.6	81.3	73.5	72.5	68.2	S	-	-	-	-	-	-	85.6	42.4	75.6	..
D	Dental distocclusion		23.0	23.5	14.7	24.6	26.1	29.0	S	-	-	-	-	-	-	13.0	57.6	1.3	...
M	Dental mesiocclusion		1.9	1.9	3.8	1.9	1.4	1.8	-	-	-	-	-	-	-	0.6	0	23.1	..
P1	Anterior crossbite (negative overjet)		1.9	1.9	2.1	0	1.8	2.1	-	12	1.3	3	1.1	8	29.6	1.6	1.7	10.3	..
P2	Posterior crossbite, maxilla to lingual		5.7	5.2	4.8	5.7	6.3	6.9	S	54	6.0	12	4.3	3	11.1	4.6	6.3	15.4	..
P2b	Posterior crossbite, maxilla to buccal		1.0	0.7	0	0.9	1.0	2.8	S	3	0.3	9	3.3	0	0	1.0	1.4	0	-
P3	Incisor overjet, tip of upper to lower labial > 3 mm.		39.4	39.9	14.1	44.2	58.1	49.2	?	270	30.2	197	71.6	3	11.1	32.8	65.2	14.1	...
P4	Incisor overjet, tip of lower to upper lingual > 0		22.4	34.7	11.7	30.6	22.6	12.9	S	14	14.5	106	38.5	1	3.7	19.8	34.0	9.0	...
P5	Overbite of upper incisor > 1/2 lower incisor		24.6	25.0	10.3	24.9	36.5	30.8	S	163	18.3	127	46.2	3	11.1	20.4	39.9	11.5	...
P6	Anterior openbite > 0		4.5	8.2	2.1	3.8	3.8	4.6	?	41	4.6	10	3.6	2	7.4	4.5	4.5	3.8	-
P7	> 3 mm. of open contacts in upper permanent arch		7.0	0	0.3	2.4	17.3	18.9	S	63	7.1	16	5.8	4	14.8	6.3	5.9	17.9	..
P8	> 3 mm. of open contacts in lower permanent arch		4.3	0	0.3	0.9	7.2	15.2	S	33	3.7	14	5.1	4	14.8	3.3	3.5	17.9	-
P9	Mid-line diastema > 2 mm.		2.6	1.9	4.1	4.2	1.9	0.9	S	26	2.9	5	1.8	1	3.7	3.2	1.4	2.6	..
P10	Simple malposition with space available		10.6	1.1	4.1	2.8	1.1	28.5	S	97	10.9	29	10.5	1	3.7	10.3	10.4	15.4	-
P11	Crowding of upper teeth with space need > 3 mm.		8.3	1.1	0	15.0	3.9	16.6	..	60	6.7	37	13.4	3	11.1	6.3	12.5	15.4	..
P12	Crowding of lower teeth with space need > 3 mm.		9.5	1.9	0	16.9	9.2	15.2	..	79	8.8	33	12.0	2	7.4	9.0	10.4	12.8	-
T1	Premature loss in deciduous buccal segment		15.2	0.7	15.1	32.4	0.2	1.8	S	135	15.1	40	14.5	7	25.9	15.5	13.2	20.5	-
T2	Loss of one or more permanent teeth (excl. ortho.)		3.4	0.4	0	0.5	4.3	13.4	S	32	3.6	8	2.9	0	0	2.8	2.8	11.5	..
T2a	Orthodontic extraction of permanent tooth		0.5	0	0	1.9	0	1.4	-	6	0.7	1	0.4	0	0	0.6	0.7	0	-
T3	One or more congenitally missing teeth		3.8	0	4.8	0.9	7.7	6.4	?	35	3.9	10	3.6	1	3.7	3.5	3.8	7.7	-



Item	TABLE I (continued)	Total	3yr	6yr	8yr	10yr	12yr	Sign.	Neutro.		Disto.		Mesio.		Sign.	Antero-posterior skeletal			Sign.
																n	d	m	
T4	One or more supernumerary teeth	0.6	0.4	0.7	0.5	0	1.8	-	n	%	n	%	n	%	-	%	%	%	-
T5	One or more malformed teeth	0.9	0.4	1.4	0.5	1.4	0.9	-	5	0.6	5	1.8	1	3.7	-	0.4	1.4	1.3	-
T6	Macrodonia (lower perm. incisors total width)	9.3	0	9.6	18.3	8.6	12.0	S	82	9.2	26	9.4	3	11.1	-	8.0	11.4	15.4	..
T7	Submersion or over-retention of decid. tooth	1.5	0	0.7	0.5	4.8	2.3	S	12	1.3	2	1.8	1	3.7	-	1.7	1.0	1.3	-
T8	Ectopic eruption or impaction of perm. tooth	0.4	0	0	0.5	1.4	0.5	-	4	0.5	1	0.4	0	0	-	0.3	0.3	2.5	-
T9	Uncontrolled caries	6.6	1.1	7.9	13.2	5.8	6.0	S	62	6.9	15	5.4	2	7.4	-	6.5	6.3	9.0	-
En	Skeletal base relation, B to A plane normal	60.9	74.0	46.6	62.0	64.0	60.5	?	711	79.7	108	39.3	9	33.3	..	-	-	-	-
Ed	Skeletal base relation, B to A plane distal	24.1	24.6	16.4	32.0	23.0	27.0	?	122	13.7	166	60.4	0	0	...	-	-	-	-
Em	Skeletal base relation, B to A plane mesial	6.5	1.5	2.8	6.6	12.5	12.0	S	59	6.6	1	0.4	18	66.7	...	-	-	-	-
E1	Narrow arches and/or high palate	1.0	1.1	0	2.8	1.0	0.5	-	6	0.7	6	2.2	0	0	-?	0.6	2.4	0	-
E2	Cleft palate and/or hare lip	0.1	0	0	0	0.5	0	-	0	0	1	0.4	0	0	-	0.1	0	0	-
E3	Nasal pharyngeal obstruction, adenoids, etc.	7.6	14.6	6.2	0	10.6	5.5	S	62	6.9	27	9.8	2	7.4	-	8.0	7.3	5.1	-
E4	Constitutional or endocrine defects	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E5	Behavior problem	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E6	Sucking habit non-active	13.5	3.4	8.9	20.9	17.9	20.7	S	118	13.2	42	15.3	1	3.7	..	11.4	19.4	12.8	..
E6a	Active sucking habit	18.0	36.2	20.0	9.4	12.5	6.0	S	146	16.4	62	22.5	6	22.2	..	17.4	21.9	9.0	..
E7	Facial asymmetry	0.4	0	0	0	1.0	0.9	-	1	0.1	3	1.1	0	0	-	0.3	0.7	0	-
E8	Occlusal plane to cranial base acute angle	5.2	0	0.3	5.2	11.0	12.4	S	37	4.1	21	7.6	4	14.8	..	3.3	10.1	6.4	..
E9	Occlusal plane to cranial base obtuse angle	3.8	0	0	19.7	0	1.4	?	35	3.9	9	3.3	1	3.7	-	4.5	1.7	3.9	..
	To continue: skeletal size, incisal angles, facial type, etc.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Code of significance column: S one or more items different, - no significant difference, ... all three significantly different,
 .. only lowest and highest different, -- or -- lowest or highest is significantly different from rest,
 :- lower two significantly different from rest, ? borderline or gross error suspected.

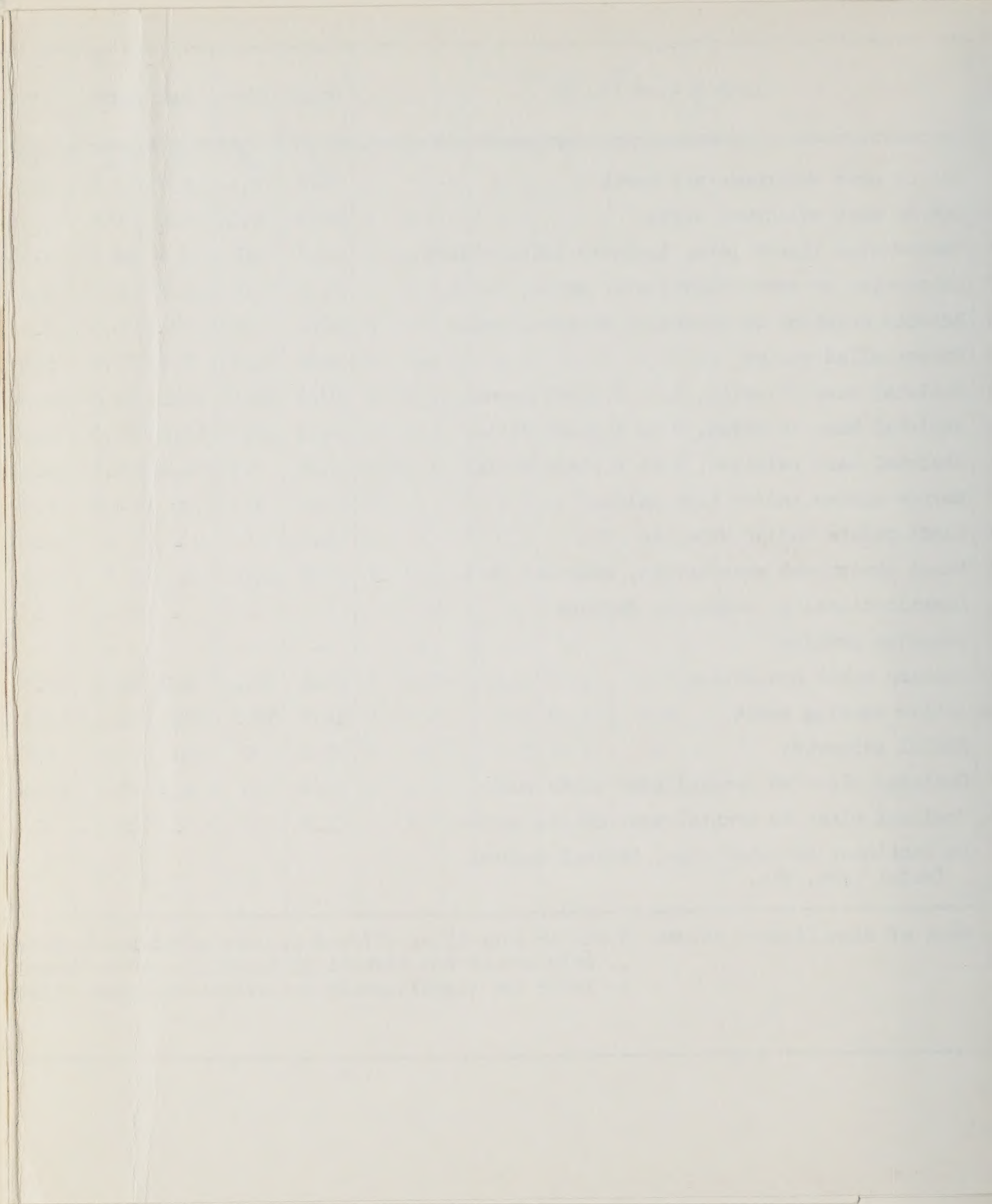


TABLE II INTERCORRELATIONS OF TOOTH POSITIONAL DEFECTS, PREDISPOSING TOOTH DEFECTS, AND GENERAL ETIOLOGIC FACTORS

Anterior Crossbite (negative overjet)	Posterior Crossbite									Incisor Overjet									Overbite >1/2 Lower Incisor	Anterior Openbite >0 (negative overbite)	Open Contacts in Permanent Teeth >3 mm									Mid-line Diastema >2 mm	Simple Malposit'n of teeth no Space Lack	Crowding out of Position of Perm. Teeth with Space Lacking >3 mm.								
	Max. to lingual			Max. to buccal			Tip of upper to lower >3mm.			Tip of lower to upper >0			P5			P6					P7			P8			P9					P10			upper P11			lower P12		
	F1	F2		F2b		F3			F4			F5			F6			P7			P8			P9			P10					P11			P12					
	N	D	M	N	D	M	N	D	M	N	D	M	N	D	M	N	D	M	N	D	M	N	D	M	N	D	M	N	D	M	N	D	M	N	D	M				
o e r	0 .7	0 .1	0 .8																																					
o e r	0 .04	0 .1	0 0	M.E																																				
o e r	Mutually Exclusive			17 16.3	9 8.6	1 .3	2 .9	6 6.4	0 0																															
o e r	M.E			15 7.9 ++	8 4.6	1 .1	0 .4	1 3.5	0 0	13 39 ++	64 76	1 .1																												
o e r	0 2.2	0 1.4	0 .8	9 9.9	8 5.5	1 .3	3 .5	4 4.2	0 0	66 49	93 91	2 .3	17 24	33 49	1 .11																									
o e r	1 0.6	0 .1	0 .6	12 2.5 ++	0 .4	0 .2	0 .1	0 .3	0 0	17 12	9 7.2	1 .2	13 6.0 ++	7 3.9	0 .07	M.E																								
o e r	0 .8	0 .2	1 1.2	2 3.8	1 .7	0 .4	0 .2	1 .5	0 0	43 19 ++	14 11	0 .4	16 9.2 ++	4 6.2	0 .15	17 12	8 7.3	1 .4	2 2.9	1 .6	0 .30																			
o e r	1 .4	0 .2	0 1.2	5 2.0 +	1 .6	0 .4	0 .1	1 .5	0 0	14 10	10 10	0 .4	6 4.8	3 5.4	0 .15	5 6.0	6 6.5	1 .4	3 1.5	1 .5	0 .30	17 2.3 ++	8 .81 ++	2 .59																
o e r	0 .3	0 .05	0 .3	2 1.6	0 .2	1 .1	0 .1	0 .2	0 0	7 7.9	4 3.6	0 .1	6 3.8	3 1.9	0 .04	0 4.8 =	1 2.3	0 .1	1 1.2	0 .18	0 .08	2 1.8	0 .29	0 .15	1 .96	1 .25	0 .15													
o e r	1 1.3	0 .3	0 .3	8 5.9	3 1.3	0 .1	0 .3	2 .9	0 0	37 29	24 21	0 .1	16 14	9 11	0 .04	21 18	15 13	0 .1	6 4.5	0 1.1	0 .08	11 6.9	2 1.7	0 15	8 3.6 +	4 1.5	0 .15	0 2.8	0 .53	0 .04										
o e r	1 .8	1 .4	1 .8	5 3.6	2 1.6	0 .3	0 .2	0 1.2	0 0	24 18	23 27	0 .3	12 8.7	9 14	0 .11	21 11 ++	18 17	0 .3	2 2.8	0 1.3	0 .22	M.E			1 2.2	0 .9	0 .4	0 1.7	0 .67	0 .11	7 6.5	4 3.9	0 .11							

Table Cont'd		P1			P2			P2b			P3			P4			P5			P6			P7			P8			P9			P10			P11			P12		
		N	D	M	N	D	M	N	D	M	N	D	M	N	D	M	N	D	M	N	D	M	N	D	M	N	D	M	N	D	M	N	D	M	N	D	M			
P12	o	2	1	0	5	1	0	0	1	0	32	23	1	17	7	0	27	18	1	1	1	0	5	1	0	M.E			0	0	0	14	4	0	37	17	0			
	e r	1.1	.4	.6	4.8	1.4	.2	.3	1.1	0	24	24	.2	12	13	.07	14	15	.2	3.6	1.2	.15	5.6	1.9	.30				2.3	.60	.07	8.6	3.5	.07	53	4.4	.2			
T1	o	2	2	1	9	1	0	0	0	0	44	26	1	28	15	0	22	19	1	5	2	0	6	2	0	3	1	0	4	0	0	8	3	0	23	10	1	23	9	1
	e r	1.8	.4	2.1	8.2	1.7	.8	.4	1.3	0	41	29	.8	20	15	.26	25	18	.8	6.2	1.5	.52	9.5	2.3	1.0	5.0	2.0	1.0	3.9	.73	.26	14.7	4.2	.26	9.1	5.4	.8	12	4.8	.5
T2	o	1	0	0	3	0	0	0	0	0	10	5	0	1	2	0	6	4	0	2	0	0	4	1	0	8	3	0	1	0	0	9	3	0	4	0	0	3	1	0
	e r	.4	.1	0	1.9	.3	0	.1	.3	0	9.7	5.7	0	4.7	3.1	0	5.8	3.7	0	1.5	.3	0	2.3	.47	0	1.2	.41	0	.93	.14	0	3.5	.84	0	2.2	1.1	0	2.8	1.0	0
T2a	o	1	0	0	1	0	0	0	0	0	1	1	0	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	2	0	0
	e r	.08	.01	0	.4	.04	0	.02	.03	0	1.8	.7	0	.9	.4	0	1.1	.46	0	.28	.04	0	.42	.06	0	.22	.05	0	.17	.02	0	.65	.11	0	4.0	.13	0	.53	.12	0
T3	o	0	0	3	3	4	0	0	0	0	11	5	0	7	0	0	8	5	0	2	0	0	9	1	0	2	3	0	3	1	0	6	2	0	3	3	0	3	3	0
	e r	.5	.1	.3	2.1	.4	.1	.1	.3	0	10.6	7.2	.1	5.1	3.9	.04	6.4	4.6	.1	1.6	.36	.74	2.5	.58	.15	1.3	.51	.15	1.0	.18	.04	3.8	1.1	.04	2.4	1.3	.1	3.0	1.2	.74
T4	o	0	0	0	0	0	0	0	0	0	3	0	0	1	0	0	3	0	0	0	0	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0	0	1	1	0
	e r	.08	.02	0	.4	.1	0	.02	.1	0	1.8	1.4	0	.9	.8	0	1.1	.9	0	.3	.07	0	.42	.12	0	.22	.10	0	.17	.04	0	.65	.22	0	.41	.26	0	.53	.24	0
T5	o	0	0	0	0	1	1	0	0	0	2	2	0	0	0	0	1	3	0	0	0	0	2	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	1	0
	e r	.07	.05	.3	.3	.2	.1	.02	.2	0	1.5	3.6	.1	.7	1.9	.04	.9	2.3	.1	.2	.18	.07	.35	.06	.15	.18	.25	.15	.14	.09	.04	.54	.53	.04	3.4	.67	.1	.44	.60	.07
T6	o	2	1	0	7	1	1	0	0	0	22	17	0	14	8	0	17	12	0	2	0	0	2	0	1	1	2	1	0	0	1	11	3	0	17	4	0	21	2	0
	e r	1.1	.3	.9	5.0	1.1	.3	.3	.9	0	25	19	.3	12	10	.11	15	12	.3	3.8	.94	.22	5.8	1.5	.45	3.0	1.3	.45	2.4	.47	.11	8.9	2.7	.11	5.5	3.5	.3	7.3	3.1	.22
T7	o	0	0	0	2	0	0	2	0	0	6	4	0	2	2	0	6	3	0	0	1	0	1	0	0	1	1	0	1	1	0	0	0	0	0	0	0	1	1	0
	e r	.2	.02	.3	.7	.1	.1	.04	.1	0	3.6	1.4	.1	1.7	.8	.04	2.2	.9	.1	.6	.07	.07	.85	.12	.15	.44	.10	.15	.35	.04	.04	1.3	.22	.04	.81	.26	.1	1.1	.24	.07
T8	o	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0	3	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0
	e r	.05	.01	0	.2	.04	0	.01	.03	0	1.2	.7	0	.6	.4	0	.7	.46	0	.18	.04	0	.28	.06	0	.15	.05	0	.12	.02	0	.43	.11	0	.27	.13	0	.35	.12	0
T9	o	2	0	0	5	0	0	0	0	0	17	10	0	11	5	0	10	3	0	1	0	1	0	1	0	2	1	0	0	0	0	9	1	0	12	6	0	11	4	0
	e r	.8	.2	.6	3.8	.7	.2	.2	.5	0	19	11	.2	9.0	5.8	.08	11	6.9	.2	2.8	.55	.16	4.4	.87	.30	2.3	.76	.30	1.8	.27	.08	6.7	1.6	.08	4.2	2.2	.2	5.5	1.8	.16
E1	o	1	0	0	2	2	0	0	0	0	4	5	0	2	4	0	1	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	e r	.08	.07	0	.4	.3	0	.02	.2	0	1.8	4.3	0	.9	2.3	0	1.1	2.8	0	.3	.22	0	.42	.35	0	.22	.31	0	.17	.11	0	.65	.63	0	4.0	.81	0	.53	.72	0
E2	o	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	e r	0	.01	0	0	.04	0	0	.03	0	0	.7	0	0	0	0	0	.46	0	0	.04	0	0	.06	0	0	.05	0	0	.02	0	0	.11	0	0	0	.13	0	0	.12

TABLE II (continued) INTERCORRELATIONS OF TOOTH POSITIONAL DEFECTS, PREDISPOSING TOOTH DEFECTS, AND GENERAL ETIOLOGIC FACTORS

S		Anterior Crossbite (negative overjet)			Posterior Crossbite						Incisor Overjet						Overbite >1/2 Lower Incisor			Anterior Openbite >0 (negative overbite)			Open Contacts in Permanent Teeth >3 mm						Mid-line Diastema >2 mm.			Simple Malposit'n of teeth no Space Lack			Crowding out of Position of Perm. Teeth with Space Lacking >3 mm.																			
					Max. to lingual			Max. to buccal			Tip of upper to lower >3mm.			Tip of lower to upper >0									upper			lower																												
		P1			P2			P2b			P3			P4			P5			P6			P7			P8			P9			P10			upper P11			lower P12																
		N	D	M	N	D	M	N	D	M	N	D	M	N	D	M	N	D	M	N	D	M	N	D	M	N	D	M	N	D	M	N	D	M	N	D	M	N	D	M														
E3	o e r	0 .8	0 .3	1 .6	3 3.8	2 1.2	0 .2	0 .2	0 .9	0 0	15 19	25 19	0 .2	10 9.0	12 10	0 .08	12 11	8 12	0 .2	4 2.8	2 1.0	0 .16	5 4.4	2 1.6	0 .30	3 2.3	2 1.4	0 .30	1 1.8	0 .49	0 .08	9 6.7	2 2.8	0 .08	5 4.2	1 3.6	0 .2	3 5.5	2 3.2	1 .16														
E4	o e r																		NOT RECORDED																																			
E5	o e r																		NOT RECORDED																																			
E6	o e r	1 1.6	0 .5	1 .3	12 7.1	1 1.8	0 .1	0 .4	0 1.4	0 0	46 36	32 30	1 .1	29 17	18 16	0 .04	26 22	19 19	0 .01	8 5.4	2 1.5	0 .07	11 8.3	0 2.4	0 .15	5 4.4	1 2.1	0 .15	6 3.4	0 .76	0 .04	15 12.8	5 4.4	0 .04	16 7.9	8 5.7	0 .1	12 10	3 5.0	0 .07														
E6a	o e r	2 2.0	1 .7	1 1.8	13 8.8	5 2.7	2 .7	0 .5	1 2.0	0 0	65 44	49 44	0 .7	55 21	42 24	1 .2	9 27	14 29	1 .7	16 6.7	6 2.3	1 .44	3 10.3	1 3.6	1 .89	3 5.4	1 3.2	0 .89	6 4.3	2 1.1	0 .20	18 15.9	1 6.5	1 .20	5 9.8	2 8.3	0 .7	6 13	3 7.4	0 .44														
E7	o e r	0 .01	0 .03	0 0	0 .1	0 .1	0 .00	0 .1	0 0	0 0	1 .3	3 2.1	0 0	1 .1	2 1.2	0 0	0 .18	7 14	0 0	1 .05	0 .11	0 0	2 .07	0 .17	0 0	0 .04	0 .15	0 0	0 .03	0 .05	0 0	0 .11	3 .33	0 0	1 .07	2 .39	0 0	0 .09	0 .36	0 0														
E8	o e r	0 .5	0 .2	0 1.2	2 2.2	0 .9	0 .4	0 .1	0 .7	0 0	18 11	17 15	0 .4	8 5.4	6 8.1	0 .15	12 6.8	9 9.7	0 .4	0 1.7	1 .76	1 .30	5 2.6	3 1.2	0 .59	2 1.4	2 1.1	3 .59	0 1.1	0 .38	0 .15	12 4.0	6 2.2	0 .15	4 2.5	4 2.8	1 .4	1 3.3	3 2.5	0 .30														
E9	o e r	1 .5	0 .1	1 .3	0 2.1	1 .4	0 .1	0 .1	0 .3	0 0	1 11	5 6.4	0 .1	10 5.1	3 3.5	0 .08	4 6.4	3 4.2	0 1	1 1.6	1 .33	0 .07	1 2.5	1 .52	0 .15	0 1.3	0 .46	0 .15	3 1.0	0 .16	0 .08	1 3.8	0 .95	0 .08	3 2.4	2 1.2	0 .1	0 3.1	3 1.1	0 .07														
E10, 11, 12, etc. to continue																																																						

o, observed number of joint occurrences. e, theoretical number of joint occurrences if factors are independent. r, correlation expression for the particular group N, D or M. The signs — or + indicate that the correlation for combined set was significant. Interaction indicates cases where the combined correlation is not significant when a significant relation was present for one of the sub-groups.

SUMMARY OF A STUDY OF GONIAL ANGLE AND MANDIBULAR LENGTH IN NORMAL CHILDREN AND CHILDREN WITH CLEFT PALATE (AT SIX, EIGHT, AND TEN YEARS OF AGE). *

by J.A.Bimm, D.A.Eisner and C.R.Ibanez

This study was aimed at evaluating the significance of mandibular morphology in normal children compared with those having cleft palate. The records for children with cleft palate were obtained from the Cleft Palate Clinic of the Hospital for Sick Children, Toronto, and those of children considered to be normal, from the files of the Burlington Orthodontic Research Centre. None of the affected children had received orthodontic therapy at the time that the records were used, although all had had surgical correction of the cleft. The composition of the samples was as follows:

AGE NEAREST BIRTHDAY (YRS.)	SEX	CLEFT N	NON-CLEFT N
6	M	25	20
	F	25	20
8	M	25	20
	F	15	20
10	M	23	20
	F	17	20

Two measurements gonial angle and mandibular length were made on oblique cephalograms. Both correlation and analysis of variance techniques were applied to the data.

It was concluded that:

1. The mandibles of the surgically treated but orthodontically untreated children with cleft palate were characterized by a greater gonial angle than that found in the mandibles of normal children.

* This study will not be included in full but is available at the Library, Faculty of Dentistry.

2. No significant sex difference was found in gonial angle.
3. There was a consistent, but insignificant, tendency to a shorter than normal mandibular length in the children with cleft palate, although this dimension tended to approach normal values with increase in age. Moreover, the findings showed that females are either more severely affected recover later, or more slowly.
4. Males were found to have significantly larger mandibular length than females, and it appeared likely that the difference might increase with age.
5. No correlation was found between gonial angle and mandibular length in the normal children at any of the age levels studied.
6. The large gonial angle associated with palatal clefts is related to the function or position of the mandible in these cases.
7. Caution should be exercised in comparing findings obtained from lateral cephalograms with those obtained from oblique projections.

THE MORPHOLOGY OF THE NASAL SEPTUM AREA

IN CLEFT AND NON-CLEFT CHILDREN

T. B. Coupe Research Institute The Hospital for Sick Children, Toronto.

In children born with any type of cleft lip and palate anomaly the nasal septum and the surrounding oro-facial area is of more than usual etiological and developmental interest. This study is therefore being carried out to determine whether there are any detectable differences in the morphology of the nasal septum between non-cleft children and children with some type of cleft lip and palate anomaly.

An estimation of the size and shape of the nasal septum can be gained by tracing this area on a lateral cephalometric x-ray and making measurements between anatomical points such as anterior nasal spine and nasion to the inferior border of the sphenoid bone at the spheno-occipital synchondrosis. The cephalometric x-rays of non-cleft children were obtained from the Burlington Orthodontic Research Centre and those of the cleft lip and palate children from the Cleft Lip and Cleft Palate Research and Treatment Centre, The Hospital for Sick Children, Toronto.

Comparisons are being made between groups of fifty non-cleft children at 6, 8, 10 and 12 years of age and similar numbers of cleft lip and palate children.

The cleft sample has also been divided into four different groups according to the type and degree of the anomaly as seen at birth. Comparisons of each type of cleft lip and palate with the non-cleft sample, as well as comparisons with the other cleft types show that significant differences do occur.

CRANIAL BASE AND CERVICAL VERTEBRAE IN CLEFT PALATE

R. B. Ross Research Institute, The Hospital for Sick Children, Toronto.

This study was intended to investigate one aspect of the morphological disturbances associated with a cleft of the lip or palate, specifically in the region of the skull base. Malformations of the cervical vertebrae were noted also, and an attempt was made to correlate the findings in light of the embryology of the areas concerned.

The sample consisted of 342 individuals with lip and palate clefts of various types. 200 children from the Burlington study were used as controls for the cranial base investigation. 800 Burlington children were used for the vertebral anomaly study.

The findings showed that the cranial base in individuals with clefts is unaffected in relative size or proportion, and only very slightly changed in configuration. Thus, the effects of a cleft do not extend appreciably beyond the maxillary complex into the area studied.

A higher incidence of vertebral anomalies was noted in cleft individuals. The most severe malformations were invariably in the isolated cleft palate group. Although cranial shape was altered when a severe anomaly was present, the only size difference in the cranial base was in the posterior portion.

AN EVALUATION OF THE MEASUREMENT OF UNERUPTED INCISORS FROM THE P.A. CEPHALOMETRIC FILM. This report was prepared by Lorne Scott.

The purpose of this study was to evaluate the accuracy of measurement of the mesiodistal diameter of the four mandibular and four maxillary permanent incisors from standard postero-anterior headfilms. This was done by comparing the measurement of the teeth on the P.A. cephalometric headfilm with the measurement of the teeth after eruption on the corresponding models. The unerupted teeth were measured individually, with calipers accurate to a tenth of a millimetre from the six year serial record P.A. headfilm. The erupted teeth were measured with similar calipers on the nine year record models of the same children. In the cases of severe rotations in the headfilm or erupted teeth on the model, the measurement of the tooth on the opposite side was taken. If this was not possible, the case was eliminated from the study.

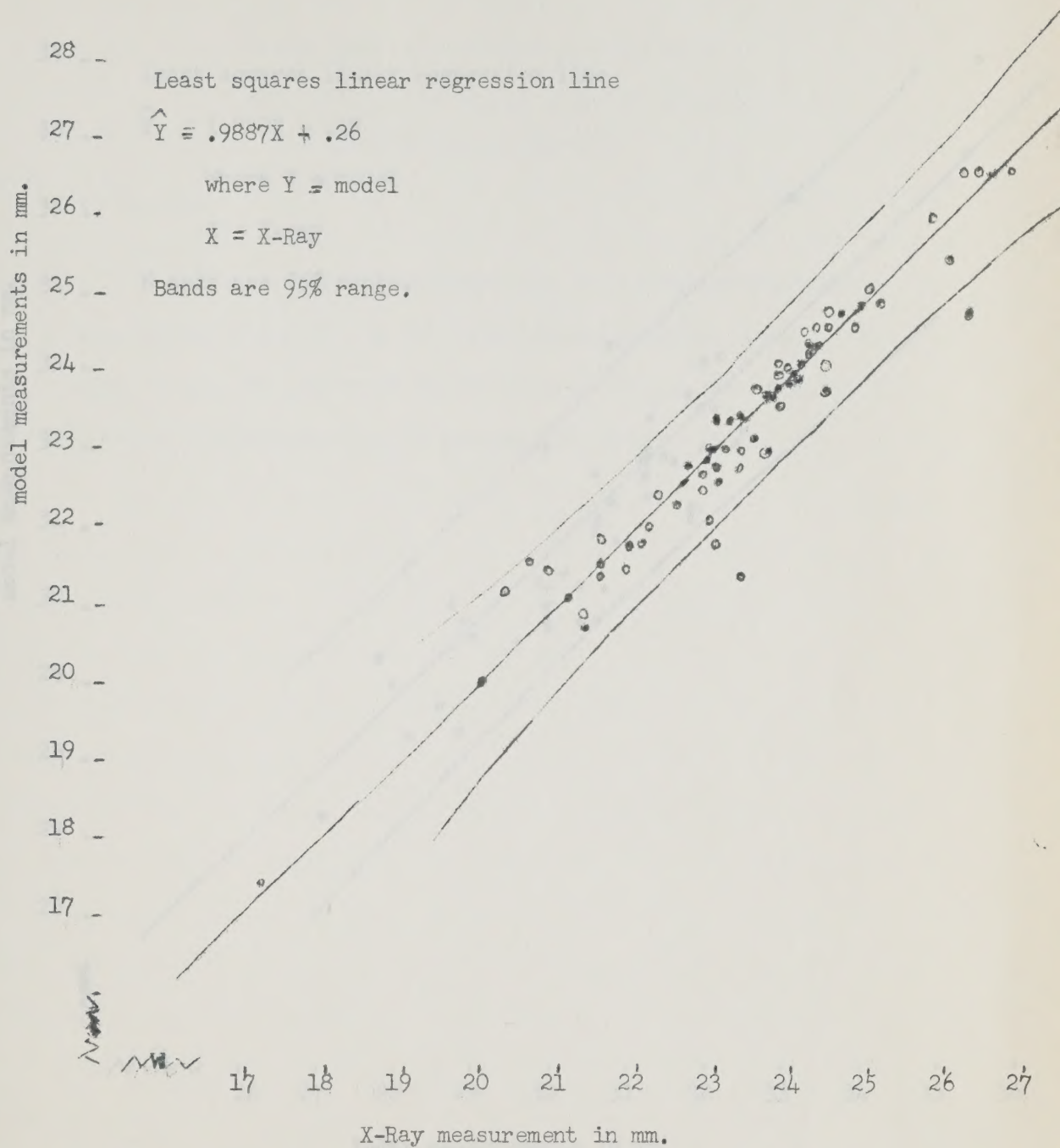
The sum of the four maxillary and mandibular incisor widths of seventy-seven cases are recorded in graph form with the headfilm measurements on the horizontal axis and the model measurements on the vertical axis. The straight line which passes through the clumps is the least squares linear regression line. The band represents ninety-five percent of the cases. Where Y is the model and X the headfilm measurement, in the maxilla $\hat{Y} = 1.020X + .19$ and in the mandible $\hat{Y} = .9887X + .26$.

Obviously, there is a very close relationship between the two measurements.

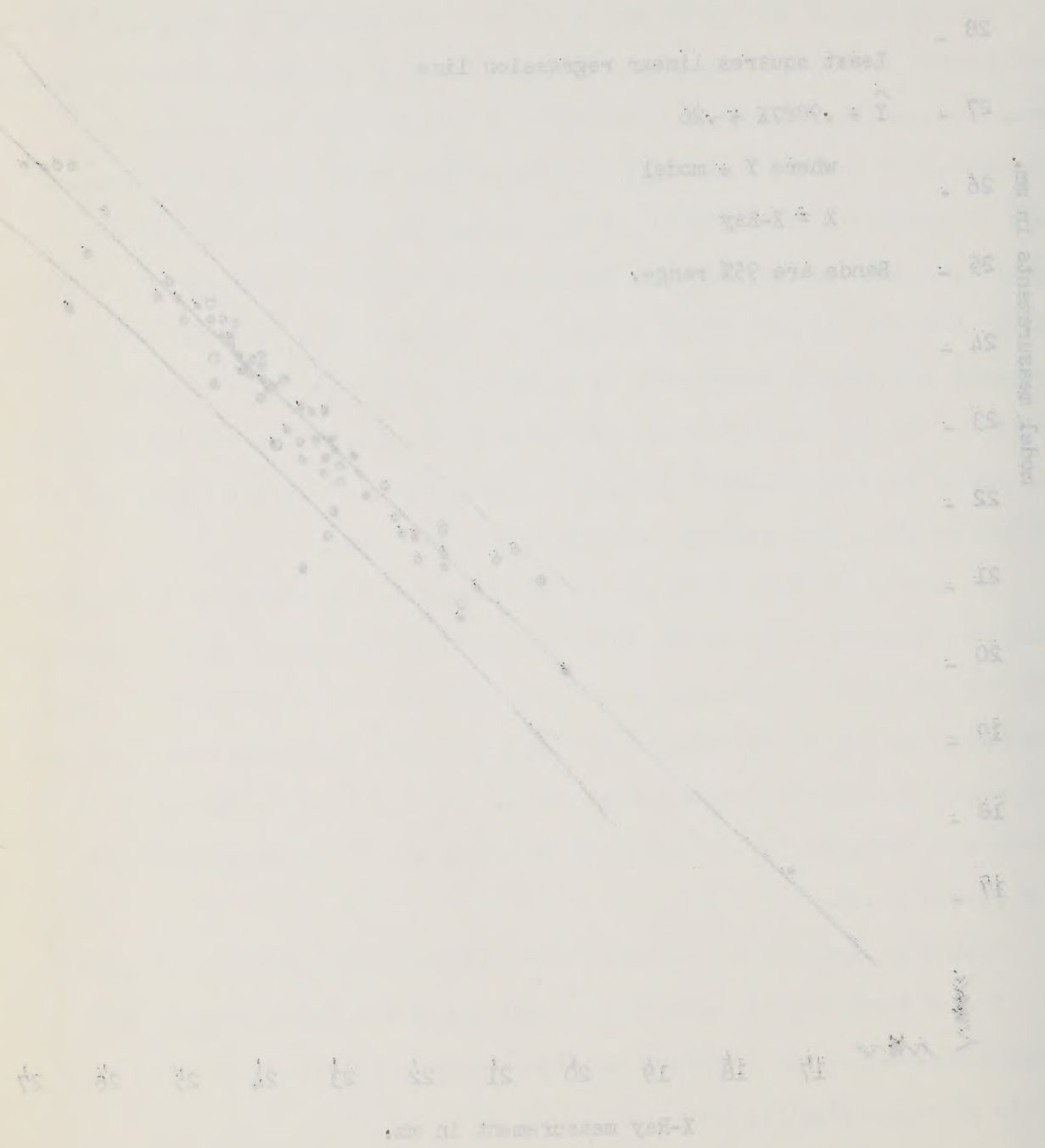
It was found that the size of the teeth was on the whole, very slightly underestimated from the headfilms but this obviously was so slight as to be of little practical significance.

Therefore, we can conclude that estimation of the mesiodistal diameter of the four permanent, unerupted mandibular incisors and the four permanent unerupted maxillary incisors from postero-anterior headfilms is a reliable procedure.

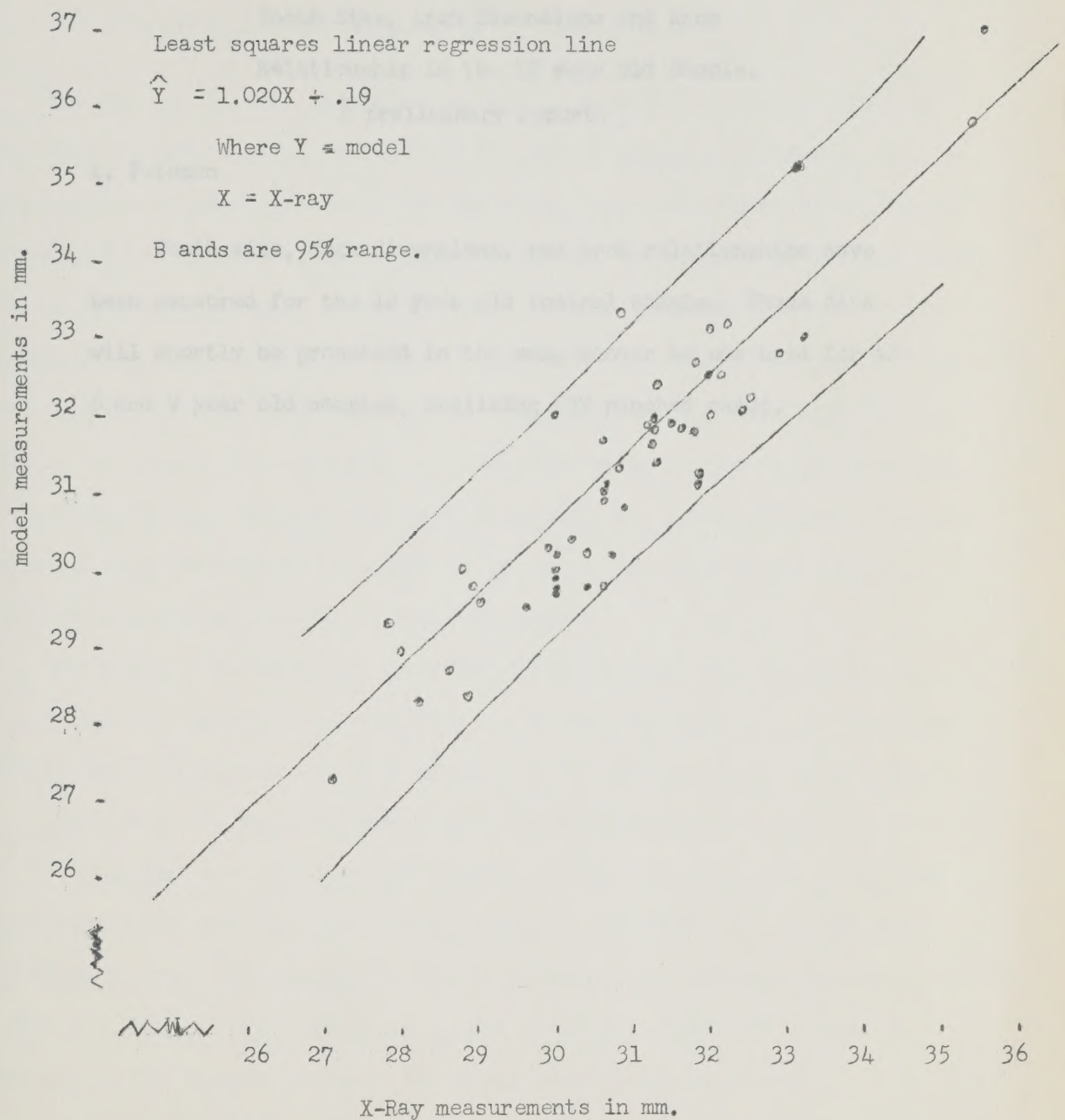
SUM OF WIDTH OF MANDIBULAR INCISOR TEETH



SUM OF SQUARES OF INDIVIDUAL INDIAN TEETH



SUM OF WIDTHS OF MAXILLARY INCISOR TEETH



Tooth Size, Arch Dimensions and Arch Relationship in the 12 year old Sample.

A preliminary report.

A. Feldman

Tooth size, arch dimensions, and arch relationships have been measured for the 12 year old control sample. These data will shortly be processed in the same manner as was used for the 6 and 9 year old samples, utilizing IBM punched cards.

TOOTH SIZE, SPACING-CROWDING, ARCH RELATIONSHIPS
AND ARCH DIMENSIONS IN SIX AND NINE YEAR OLD CHILDREN.

This report was prepared by W. Stuart Hunter.

The purpose of this investigation was to describe and assess the teeth and their relationship to each other in a random sample of untreated children. While similar studies have been done by other investigators including Seipel⁴, Lundstrom² and Moorrees³, it was found advisable to repeat some of their work for two general reasons. First, it was necessary to establish standards for an untreated random sample for which the general demographic factors are the same as for the experimental group; second, a number of measurements will have to be made on the experimental group, for which as yet no satisfactory comparisons exist. These mostly have to do with the considerations of antero-posterior relationship of the lower to the upper jaw in terms of metric measures rather than the Angle classification.

The sample described here consists of the six year control group, seen at this age and again at age nine years. While the data are, in this study, principally cross-sectional they are also to a limited extent longitudinal.

There were 294 children whose casts could be measured at age six (9 from the total sample were not measured because of very extensive decay and loss of tooth structure) and 237 at age nine. Table 1 summarizes the age breakdown according to sex. The reason for the relatively large standard deviation for 6 year old males is that initially it was found more difficult to get the children in for records on their birthdays than it was later on.

It might be well to point out here that this study of the teeth and their relationships was not designed to study caries incidence. While the effect of decay on spacing-crowding for example, can be extensive, decay which is associated with loss of arch dimension is obviously much more readily

detected than that which is not.

METHOD

The casts were measured over a six month period by one investigator using the same instruments throughout. The technique was standardized as fully as possible as suggested by Hunter and Priest¹. Each set of casts at age nine was measured immediately after the corresponding set of casts for the subject at age six.

A sliding caliper (Helios style) reading to 0.1 mm. was used for the measures to which it is suited.

Tooth Size and Arch Perimeter.

Mesiodistal tooth diameter was measured from the labial or buccal from contact point to contact point with the beaks of the instrument perpendicular to the line of the contacts in the case of correctly positioned teeth. In the case of rotated teeth, the contact points which would exist if the tooth were correctly positioned, were used. Within these limitations, the widest mesiodistal diameter was selected. Both left and right sides were measured. In the case of partially erupted or missing teeth, the measurement for its antimere was inserted if available. It is believed that in such cases the antimere is an acceptable substitute. Restored and carious teeth were measured where the restoration was well contoured or the caries did not affect the mesiodistal diameter. These measures were coded as to type for comparison with non-restored and non-carious tooth measures. Teeth having bands in place or crowns were not distinguished from missing teeth.

Arch length was measured in three segments in each of the four quadrants:

(1) from the mid-point between the central incisors to the mesial contact of the cuspid (2) from the mesial contact of the cuspid to the mesial contact of the first primary molar or bicuspid (3) from the mesial contact of the first primary molar or bicuspid to the distal contact point of the second primary molar or bicuspid.

Definitions of Measurements of Arch Relationship and Size.

Antero-posterior Relation of Anteriors, I: (See Fig. 1, page 82)

The distance recorded to the nearest 0.1 mm., from the middle of the labioincisal edges of the central incisors of one arch, usually the maxillary, to the labial surfaces of the central incisors of the arch posterior to it when the teeth are in occlusion. The distance is measured parallel to the occlusal plane of the buccal segments. If different values are obtained for the two central incisors, the average value is taken.

This was taken after Moorrees with respect to the vertical position for the measurement on the most anterior tooth. That is, the depth gauge part of the Helios gauge was used, so that this measure is from the most prominent part of the face of the maxillary incisor rather than from the incisal edge.

Antero-posterior Relations of Anteriors, II: (See Fig. 1, page 82)

The distance recorded to the nearest 0.1 mm., from the labio-incisal edges of the central incisors of one arch, usually the mandibular, to the lingual surfaces of the central incisors of the arch anterior to it when the teeth are in occlusion.

The distance is measured parallel to the occlusal plane of the buccal segments and theoretically, two measures were to have been averaged.

However, it was estimated by subtraction of the thickness of the maxillary incisor at the level of the incisal edge of the mandibular incisor (casts in occlusion) from the measure for AP Relation 1.

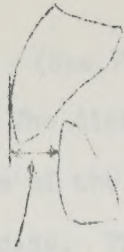
Antero-posterior Relation of Molars: (See Fig. 1, page 82)

The distance recorded to the nearest 0.1 mm., from the tip of the mesiobuccal cusp of the maxillary first permanent molar to the buccal groove of the mandibular first permanent molar. This is measured parallel to the occlusal plane. In the deciduous dentition, the measurement is obtained from the deciduous second molars.

The landmarks were marked with a sharp pencil. The values were arbitrarily entered as positive when the mandibular landmark was posterior to (distal to) the maxillary landmark and negative when the maxillary landmark was distal to the mandibular.

Antero-posterior Relation of Cuspids: (See Fig. 1, page 82)

The distance, recorded to the nearest 0.1 mm., from the tip of the maxillary cuspid to the distal surfaces of the mandibular cuspid. This is measured parallel to the occlusal plane. If the mandibular cuspids are not erupted beyond their greatest mesiodistal width, the measurement is made to the mesial surface of the deciduous first molar and the fact that this has been done is indicated.



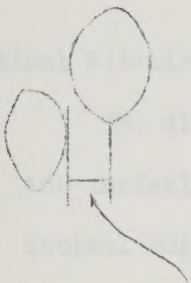
Antero-posterior
Relationship I
of Anterior Segment



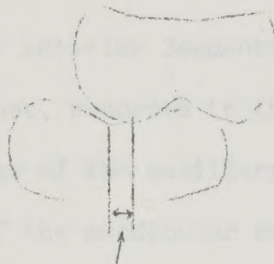
Antero-posterior
Relationship II
of Anterior Segment



Positive midline
discrepancy (mandibular
midline is to subject's
right of the maxillary
midline).



Negative Cuspid and Molar
Relationships. Left side.



Positive Cuspid and Molar
Relationships. Left side.

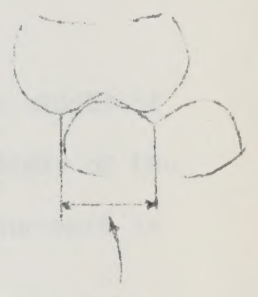
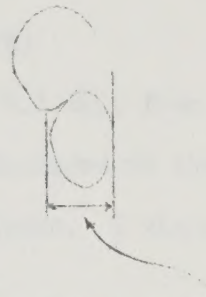
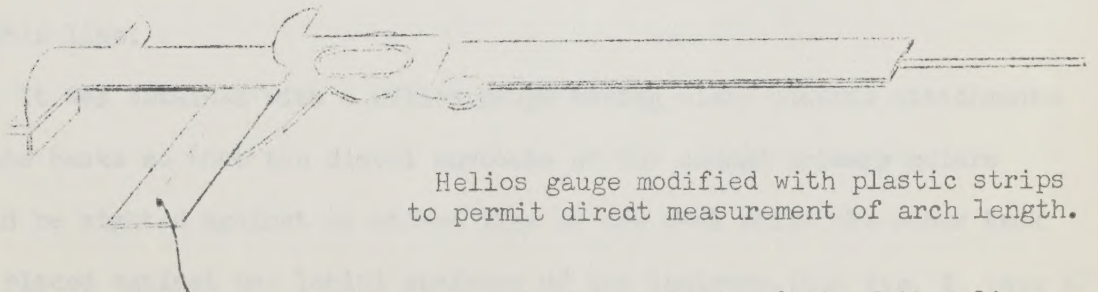


Figure 1. The method of taking several of the measurements used in this study.



Helios gauge modified with plastic strips
to permit direct measurement of arch length.

Since the etched line is 10 mm. ahead of the sliding beak of the cliper, 10 mm. must be subtracted from the reading.

Figure 2. One of the modifications made to a Helios gauge to permit, in this instance, a direct reading of arch length perpendicular to a line between the distal contacts of the right and left second primary molars.

Midline: (See Fig. 1, page 82)

The distance, recorded to the nearest 0.1 mm., between the centre lines of the mandibular and maxillary arches, when they fail to coincide. The measurement is made when the teeth are in occlusion.

The maxillary midline was transferred to the mandibular cast and entered as positive when the mandibular midline was to the right (subject's right) of the maxillary midline.

Vertical Relation of Anterior Segments: (OVERBITE)

The distance, recorded to the nearest 0.1 mm., from the middle of the incisal edge of the maxillary central incisors to the middle of the incisal edge of the mandibular central incisors. This measurement is made at right angles to the occlusal plane.

A sharply pointed pencil was used to mark the mandibular incisors appropriately and the overbite was then measured with a specially ground Helios gauge having stepped beaks.

Arch Length:

The distance recorded to the nearest 0.1 mm., from the midpoint of the line joining the distal surfaces of the second deciduous molars to the point on the labial surface of the arch crossed by the perpendicular to this line.

It was obtained with a Helios gauge having clear plastic attachments on the beaks so that the distal contacts of the second primary molars could be sighted against an etched line on one beak while the other beak was placed against the labial surfaces of the incisors. (See Fig. 2, page 82)

Arch Width:

The distance between the left and right deciduous second molars or permanent second bicuspid. The points of measurement are taken at the distal surfaces of the teeth where a line through the central sulcus of the tooth crosses the distal surface. In the case of rotated teeth, the point where the line would cross the distal surface of the tooth were it not rotated, is used.

Palate Depth:

The depth of the palate measured at right angles to the occlusal plane from the midpoint of the line joining the distal surfaces of the second deciduous molars or second bicuspid.

This was measured from the cusp tips using a plastic plate and the depth rod on the Helios gauge. While this was thought to be rather inaccurate, the other method available, using a divider gauge was just as inaccurate and considerably more time consuming.

Combined Mesiodistal Diameters:

This quantity was obtained for each quadrant separately and includes all measures obtained including those on restored and slightly carious teeth (where the decay did not materially alter the conformation of the teeth at the contact points). It was also recorded for each arch as the sum of the values for the appropriate quadrants.

The Arch Perimeter.

This was also calculated for each quadrant and arch in the manner specified under tooth size and arch perimeter (pp. 79-80)

The Spacing-Crowding.

This was obtained for each quadrant and arch by subtracting the combined mesiodistal diameter value from the corresponding arch perimeter value. (See Appendix A, page 114)

In addition, every 15th case was remeasured for analysis of the measurement error. In the statistical analysis of these replication differences, each second measure was subtracted from the corresponding first measure and the differences were then accumulated to give an average value with its associated variance. (See Appendix A, page 114)

FINDINGS

The errors of measurement (average replication differences) were found to be of similar size or smaller than those usually found for this type of study (Seipel⁴ p.27 Lindstrom² p.60). Table 2 and Table 3 present the mean difference and their corresponding 't' values. The mean replication difference for no tooth was in excess of 0.1 mm. and only one, that for the lower right second primary molar in the six year old sample, had a significant 't' value. On the other hand, the mean replication differences for arch perimeter measures were larger, with 4 of the 24 exceeding 0.1 mm. but less than 0.5 mm. Again, only one, that for the lower right molar segment in six year olds had a significant 't' value. The variance values in terms of the standard deviation of the mean, are also shown in these tables and they are quite low, suggesting minimal measurement variation. Essentially, these values (under S.D._m) indicate the limits within which 68% of other similarly determined mean differences will be found. Thus, the average

value for the maxillary left central incisor replications would be between $-.011$ mm. and $+.033$ mm. 68% of the time. The variance can in this situation be seen as a test of bias. It is of interest that values for the nine year old mandibular measures are highest, which may be the result of an investigator fatigue factor as this was the quadrant measured last in each set of casts. Since the values for the average differences also are larger for this quadrant, no significant 't' value occurs.

Consideration of Tables 4 and 5 and of Table 13 will reveal the reason for the comparisons shown in Tables 6 and 7. In Table 4 it is found that there are 127 restored maxillary teeth and 146 restored mandibular teeth. These are not concentrated in a few subjects but rather, sufficiently scattered so that if only data having no restorations in both maxillary and mandibular arches is used, there would be only 133 six year old subjects (Table 13). Similarly in the nine year old sample (Table 5) there would be only 50 subjects. It was therefore felt advisable to use the measurements of those teeth in the spacing-crowding computations, provided these measures were not greatly different from those for non carious unrestored teeth. Tables 6 and 7 therefore present a comparison of restored and unrestored teeth.

Tables 8, 9, 10 and 11 contain the information from this investigation on unrestored, non-carious teeth in terms of their mesiodistal diameters. The reason for the different sample sizes involved is again seen in Tables 4 and 5 and is due to the distribution of restored, unerupted, missing and carious teeth in the sample.

Tables 12 and 13 summarize the arch perimeter and corresponding tooth material information compiled for this study. The numbers involved are

rather smaller than the number of subjects in the sample because, despite the use of all reasonably reliable data, there are gaps in many dentitions, particularly due to shedding of the deciduous teeth. Table 13 is based on data for subjects having no visible restorations or symmetrically missing teeth.

Tables 14 and 15 are extensions of Tables 12 and 13 to a spacing-crowding index or value and are derived from Tables 12 and 13. Therefore, the same comments apply to these tables.

Table 16 is the summary of the error control study for the other variables investigated. Again each second measure was subtracted from the corresponding first measure and averages and variances computed. The large values for Cuspid Relationship, Right Side and for Maxillary Arch Length suggest further consideration of this aspect of the study.

Tables 17 and 18 present findings for 8 measures of denture relationship, six of them having to do with antero-posterior relationships at the incisors, cuspids and molars. In addition, there are six measures of arch length and width. Palate depth is also shown here.

Tables 19 and 21 are summaries of various correlation studies, performed in an exploratory fashion only.

DISCUSSION

The sample studied in this investigation is a control sample and it has been evaluated as a basis for future comparisons rather than as a definitive study in itself. Therefore, much of the data is presented with little or no comment.

However, Tables 6 and 7 merit some further consideration.

The comparisons of restored and unrestored teeth made in these tables is restricted to deciduous molars because it is in these teeth that restorations are found as will be seen in Tables 4 and 5.

With respect to these comparisons it may be observed that there is a slight tendency for restored teeth to be larger than unrestored, non carious teeth. This difference, for the 32 comparisons made, averages .02 mm. While it is interesting to hypothesize that perhaps the restored teeth were larger to begin with, and a study of buccolingual tooth diameter should perhaps be done to clarify this, the difference found is so small as to be of little practical significance. Statistically, only 2 of the differences achieve significance and it is of interest that these are for the maxillary left and right first primary molars in females. However, as the number of restored teeth is small, it may be a sampling phenomenon. Although the differences in the nine year old sample are in the same direction, they do not achieve statistical significance. All four differences are, nonetheless, in excess of the error of measurement. Thus, in this sample, the maxillary first primary molars in females which have mesial and/or distal restorations are consistently larger than the analagous non carious, unrestored teeth, and there is a similar trend in 21 of 32 such comparisons.

For the problem of spacing-crowding, it may be hypothesized that for the small number of cases in which both primary molars are restored and therefore slightly larger the combined excess will not exceed on the average, 0.5 mm. except in the maxillary left quadrant for females, where it will not on the average, exceed 0.6 mm. It remains then, to

consider whether the effects of such a trend can be detected in the spacing-crowding figures.

In Tables 12 and 13 it may be seen that for females at age six, the restored tooth material (Table 12) does indeed show larger tooth material values than does the non-carious, unrestored material (Table 13). However, the arch space is even greater, resulting in more spacing in the six year female group having restored teeth than in those having non-carious, unrestored teeth. This pattern can not be found for the males or for either sex in the nine year group, where the non carious unrestored tooth material seems greater in extent than the restored.

It may be concluded, therefore, that if the larger mesiodistal tooth diameters for restored teeth have an effect, it is masked by other factors. There is the possibility that larger teeth are more prone to caries but at the same time, are on the average, found in larger jaws.

A comparison of Tables 8 and 9 (Mesiodistal diameter, primary teeth) with similar information presented by Moorrees³ (p.81) reveals that the Burlington values are approximately .06 mm. smaller on the average, than the values presented by Moorrees. The largest difference is .17 mm. Although such comparisons are not entirely valid, since Moorrees' values are based on an average of left and right side measures, they do suggest that the data assembled here may be used with considerable confidence.

A similar comparison of permanent tooth size found in Tables 10 and 11 with Moorrees' data (p.82) shows that of 12 comparisons which can be made, Burlington dimensions are larger than those found for Boston children (by Moorrees) six times and smaller six times. Again, the size of the difference does not exceed .17 mm. except for the maxillary first molar where it is 0.4 mm.

In general, these findings on spacing-crowding are in agreement with those of Moorrees³ (pp.113-114).

Consideration of the symmetrical aspects of Tables 14 and 15 reveals that while in the maxilla the right side is more crowded, in the mandible it is the left side which is more crowded. This is a result of normal skull asymmetry. One might expect on the basis of this finding also to find that the maxillary midline is to the right (subject's right) of the mandibular midline, on the average. Tables 17 and 18 show that we found the opposite to be the case.

Two items remain to be mentioned, in that they may to some extent be compared with Moorrees' findings. The values found for vertical relation of anterior segment (OVERBITE) are smaller than those given by Moorrees³ (p.125) but the ages are not precisely comparable, which may explain this. There is agreement that the overbite increases from age 6 to age 9.

Again for ARCH LENGTH the values found here are smaller than those found by Moorrees at age 6, but at age 9 there is very close agreement. (p.89)

It is of considerable interest to note that Moorrees' graph of arch length (p.89) shows the arches to decrease in length to age 6 and then increase to age 9 when they then decrease again. The value of complete longitudinal data is thus demonstrated.

Certain correlations between some of the variables were performed in an exploratory fashion using for the most part data derived from between thirty to fifty subjects. Although these are far from complete at this time, they appear to confirm what might be expected. Thus, in

Tables 19 and 20 the very highly significant correlation between Overjet I and Overjet II means that insofar as the method of measurement is valid, the same phenomenon is being measured for both Overjet I and Overjet II.

Other instances of significant correlations are also as readily explained in terms of what was measured. Thus, the close association between Overjet and cuspid relationship means that as the overjet increases so does the distance between the cusp tip of the maxillary cuspid and the distal surface of the mandibular cuspid. Similarly, the molar relationship shifts with the cuspid relationship. This sort of correlation is to be expected and as has been pointed out by Moorrees and others, is of limited value in the individual case because of the many exceptions.

The sampling of correlations of spacing-crowding with other measures, shown in Table 21, is of interest in that spacing-crowding seems to have a negative correlation with cuspid and molar relationship as they were recorded in this study. In other words, to a statistically insignificant extent, as maxillary spacing increases, the mandibular denture is found progressively more anterior to the maxillary denture. However, since the correlations are of a very low order, it is possible that there is a random effect here and further study is indicated.

CONCLUSIONS AND SUMMARY

The data gathered here are essentially a standard for comparison and the findings have their value in that the subjects have not been systematically treated dentally to any significant extent and in that they

represent a population which can be described accurately (Report #4).

It is of interest that the average values computed in this study for mesiodistal tooth diameter and measures of arch relationship and dimension are very closely similar to values for these measures established by other investigators.

While there is some evidence that dental restorations do alter tooth size to a measureable extent, this appears to be so small a difference on the average, as to be of no practical significance in most cases. In the study of spacing-crowding, the occurrence of restored teeth is apparently random and of not sufficient frequency to produce detectable bias in measures of spacing-crowding. If, however, the occurrence of restored teeth were not random, a spurious difference having statistical significance might arise.

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3. Moorrees, C.F.A., The dentition of the growing child.
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TABLE I

Average age in months for the subjects of this investigation. In both age groups the casts of nine subjects were not measured because of extensive caries and tooth loss.

SIX YEAR GROUP	N	AVERAGE AGE IN MONTHS	S.D. _m	S.D. _s
MALES	166	72.62	0.27	3.48
FEMALES	128	72.34	0.14	1.86
TOTAL	294			
NINE YEAR GROUP				
MALES	132	108.90	0.10	1.45
FEMALES	105	108.91	0.10	1.33
TOTAL	237			

TABLE 2

Summary of Error Control Study.

Each tooth position was measured twice by the same investigator with several weeks intervening between the two measures. Arch lengths were obtained similarly. Deciduous teeth are not distinguished from permanent teeth since it is not the actual tooth size which is of interest

SIX YEAR GROUP

LEFT					RIGHT			
	N	Mean difference in mm.	S.D. _m	't'	N	Mean difference in mm.	S.D. _m	't'
MAXILLA								
I ₁	19	.011	.022	0.46	19	.000	.028	
I ₂	19	.016	.025	0.64	19	-.016	.041	0.38
C	20	.000	.025		20	.010	.030	0.33
P ₁	20	.030	.030	1.00	20	.030	.030	1.00
P ₂	20	.020	.040	0.50	20	-.025	.035	0.72
M ₁								
MANDIBLE								
I ₁	18	.011	.032	0.35	18	.028	.028	0.98
I ₂	17	.006	.025	0.24	19	.037	.053	0.70
C	20	.020	.041	0.48	20	.025	.051	0.42
P ₁	19	.058	.041	1.40	19	.032	.051	0.62
P ₂	20	.005	.033	0.15	20	.105	.045	2.35*
M ₁								
ARCH MEASURES								
MAXILLA								
I ₁ -I ₁	20	-.030	.045	0.67	20	.050	.056	0.90
C	20	.005	.062	0.08	20	.235	.264	0.89
P ₁ -P ₂	20	-.025	.075	0.33	19	.068	.056	1.23
MANDIBLE								
I ₁ -I ₂	20	-.040	.039	1.03	20	.060	.042	1.41
C	20	.010	.030	0.33	20	-.005	.042	0.15
P ₁ -P ₂	20	.025	.020	1.25	20	.090	.033	2.71*

* Significant at the 5% level of confidence.

TABLE 3 Summary of error control study.

NINE YEAR GROUP								
LEFT					RIGHT			
	N	MEAN difference in mm.	S.D. m	't'	N.	MEAN difference in mm.	S.D. m	't'
MAXILLA								
I ₁	18	-.011	.022	0.50	16	-.044	.030	1.45
I ₂	17	.035	.037	0.94	17	.029	.040	0.74
C	18	-.011	.047	0.24	18	.022	.035	0.64
P ₁	19	.058	.046	1.26	18	.044	.036	1.23
P ₂	19	.026	.040	0.66	19	-.047	.036	1.31
M ₁	17	.018	.037	0.47	15	-.047	.042	1.10
MANDIBLE								
I ₁	19	.005	.017	0.30	19	.021	.011	1.49
I ₂	19	.032	.030	0.10	19	.032	.030	0.62
C	16	.025	.020	1.25	15	-.020	.049	0.41
P ₁	17	.018	.050	0.35	17	.035	.044	0.81
P ₂	16	.038	.069	0.55	17	.059	.035	1.41
M ₁	8	-.025	.067	0.37	8	-.025	.106	0.24

ARCH MEASURES

MAXILLA								
I ₁ - I ₂	19	.026	.089	0.30	19	-.111	.082	0.14
C	19	-.005	.040	0.13	19	-.047	.036	1.31
P ₁ - P ₂	19	.058	.057	1.02	19	.458	.520	0.88
MANDIBLE								
I ₁ - I ₂	19	.016	.167	0.09	19	.068	.083	0.83
C	19	.242	.417	0.58	19	.126	.185	0.68
P ₁ - P ₂	19	.337	.378	0.89	19	-.032	.156	0.20

TABLE 3
Summary of error control study.

MIXE YOUNG GROUP									
RIGHT					LEFT				
MEAN	S.D.	difference	N	in mm.	MEAN	S.D.	difference	N	in mm.
MAXILLA									
1.45	.030	-.004	18	0.30	.037	.017	-.011	18	0.37
0.76	.040	.003	17	0.66	.037	.037	.000	17	0.37
0.64	.037	.002	18	0.74	.047	.017	-.011	18	0.47
1.23	.036	.004	18	1.30	.046	.036	.000	18	0.46
1.31	.036	-.007	19	0.66	.046	.036	.000	19	0.46
1.10	.043	-.007	17	0.43	.037	.018	.018	17	0.37
MANDIBLE									
1.43	.037	.001	19	0.30	.017	.003	.003	19	0.17
0.63	.030	.003	19	0.10	.030	.035	.005	19	0.30
0.47	.040	-.000	17	1.22	.030	.052	.022	17	0.30
0.87	.044	.032	17	0.32	.030	.030	.000	17	0.30
1.41	.032	.009	17	0.32	.030	.038	.008	17	0.30
0.26	.106	-.002	8	0.32	.037	-.002	-.002	8	0.37
ARCH MEASURES									
MAXILLA									
0.14	.085	-.111	19	0.30	.083	.036	.036	19	0.14
1.37	.030	-.007	19	0.13	.040	-.002	-.002	19	0.40
0.86	.050	.058	19	1.08	.037	.038	.001	19	0.37
MANDIBLE									
0.63	.083	.006	19	0.63	.107	.016	.016	19	0.10
0.08	.182	.120	19	0.38	.147	.043	.043	19	0.14
0.50	.156	-.032	19	0.88	.138	.037	.037	19	0.13

TABLE 4 SUMMARY OF THE TYPES OF TEETH and MEASUREMENTS MADE FOR THE SIX YEAR OLD AGE GROUP

SIX YEAR OLD MALES												
MAXILLA	LEFT						RIGHT					
	di ₁	di ₂	c	dm ₁	dm ₂	M ₁	di ₁	di ₂	c	dm ₁	dm ₂	M ₁
	or I ₁	or I ₂	or C	or P ₁	or P ₂		or I ₁	or I ₂	or C	or P ₁	or P ₂	
Not measured	16	5		8	6	151	16	6		7	5	145
Primary teeth	136	157	161	133	133		134	154	165	130	134	
Permanent teeth	5					14	6					20
Restored 1 ^o teeth				13	18					20	19	
Antimere used	7	2	1	2	3		9	5		5	4	
Unreliable	1	1	1	2							2	
Restored 2 ^o teeth												
Carious			2	7	5					3	1	
MANDIBLE												
Not measured	8	5	1	14	12	159	9	5	4	16	14	162
Primary teeth	93	153	164	117	128		88	149	160	113	129	
Permanent teeth	58	4				5	60	3				2
Restored 1 ^o teeth				24	14					23	16	
Antimere used	5	2		4	6		7	6	1	3	2	
Unreliable	1				1	1	1	1			1	1
Restored 2 ^o teeth												
Carious		1		5	4			1		10	3	
SIX YEAR OLD FEMALES												
MAXILLA	LEFT						RIGHT					
	di ₁	di ₂	c	dm ₁	dm ₂	M ₁	di ₁	di ₂	c	dm ₁	dm ₂	M ₁
	or I ₁	or I ₂	or C	or P ₁	or P ₂		or I ₁	or I ₂	or C	or P ₁	or P ₂	
Not measured	11	4		2	2	111	11	4		3	4	112
Primary teeth	102	124	129	107	112		107	122	129	105	105	
Permanent teeth	7					17	7					16
Restored 1 ^o teeth				13	12					16	10	
Antimere used	5			2	1		1	2		4	4	
Unreliable	2			1		1	1				3	1
Restored 2 ^o teeth												
Carious	2	1		4	2		2	1		1	3	
MANDIBLE												
Not measured	5	7	2	13	12	120	4	8		12	12	123
Primary teeth	52	114	1127	93	100		51	110	129	91	102	
Permanent teeth	62	6				9	69	5				5
Restored 1 ^o teeth				15	7					17	10	
Antimere used	8	1		5	6		5	5		5	3	
Unreliable	2	1			1			1		1	1	1
Restored 2 ^o teeth												
Carious				3	3					3	1	

TABLE 5 SUMMARY OF THE TYPES OF TEETH and MEASUREMENTS MADE FOR THE NINE YEAR OLD AGE GROUP

NINE YEAR OLD MALES												
MAXILLA	di ₁	di ₂	LEFT			M ₁	RIGHT			dm ₁	dm ₂	M ₁
	or I ₁	or I ₂	c or C	dm ₁ or P ₁	dm ₂ or P ₂		di ₁ or I ₁	di ₂ or I ₂	c or C			
Not Measured	2	10	7	12	8	23	3	8	75	13	11	25
Primary Teeth		8	118	73	76			5	120	80	75	
Permanent Teeth	128	109	1	6	5	107	129	115		5	7	103
Restored teeth												
Antimere used	2	5	1 5	30 9	36 5			3	2 4	27 4	32 5	
Unreliable					2			1	1	1	1	2
Restored 2 ^o teeth						2						2
Carious				2						2		
MANDIBLE												
Not measured		3	11	19	20	55		2	115	21	22	68
Primary Teeth	2	2	104	62	78		2	2	99	63	72	
Permanent Teeth	130	125	8	6	3	75	127	128	6	6	2	61
Restored 1 ^o teeth			2	36	29				2	30	27	
Antimere used		2	4	8	1		1		9	10	9	
Unreliable			2	1	1	1	2			2		1
Restored 2 ^o teeth						1						2
Carious			1	1					1			

NINE YEAR OLD FEMALES												
MAXILLA	di ₁	di ₂	LEFT			M ₁	RIGHT			dm ₁	dm ₂	M ₁
	or I ₁	or I ₂	c or C	dm ₁ or P ₁	dm ₂ or P ₂		di ₁ or I ₁	di ₂ or I ₂	c or C			
Not Measured	1	1	12	11	8	11	1	1	12	10	11	14
Primary Teeth		2	83	46	47			2	85	51	55	
Permanent Teeth	104	95	3	5	4	89	104	98	2	9	2	84
Restored 1 ^o teeth			3	32	43				3	28	31	
Antimere used		4	2	4	2			3	3	6	6	
Unreliable		2		4		1		1		1		3
Restored 2 ^o teeth		1				4						4
Carious			2	3	1							
MANDIBLE												
Not Measured			17	13	14	45			17	16	14	52
Primary Teeth			63	37	45				62	39	50	
Permanent Teeth	105	105	15	7	3	57	105	103	18	9	22	50
Restored 1 ^o teeth			2	38	33				3	33	31	
Antimer used			8	9	6			2	5	7	6	
Unreliable				1	1						1	2
Restored 2 ^o teeth						2						1
Carious					1					1	1	

TABLE 6

Summary of 't' tests of the differences in mesio-distal tooth diameter between Unrestored and Restored teeth found in the SIX YEAR sample. "dm₁" is deciduous first molar and "dm₂" is deciduous second molar.

LEFT SIDE		N	Mean in mm.	S.D. _m	S.D. _s	Diff.	't'
MAXILLA dm ₁ male	Unrestored	133	7.11	.033	.40		
	Restored	13	6.92	.122	.44	0.19	1.60
dm ₁ female	Unrestored	107	6.89	.036	0.38		
	Restored	13	7.27	.112	0.41	-0.38	3.35 *
dm ₂ male	Unrestored	134	8.94	.040	0.47		
	Restored	18	8.90	.131	0.56	0.04	0.29
dm ₂ female	Unrestored	112	8.79	.039	0.41		
	Restored	12	9.00	.160	0.55	-0.21	1.64
MANDIBLE							
dm ₁ male	Unrestored	110	7.77	.042	0.45		
	Restored	23	7.63	.077	0.37	0.14	1.42
dm ₁ female	Unrestored	84	7.60	.047	0.43		
	Restored	14	7.69	.123	0.46	-0.10	0.76
dm ₂ male	Unrestored	128	9.90	.037	0.44		
	Restored	14	9.95	.092	0.35	-0.05	0.45
dm ₂ female	Unrestored	100	9.73	.045	0.45		
	Restored	7	9.86	.148	0.39	-0.13	0.72

RIGHT SIDE

		N	Mean in mm.	S.D. _m	S.D. _s	Diff.	't'
MAXILLA dm ₁ male	Unrestored	130	7.08	.033	0.39		
	Restored	20	7.10	.114	0.51	-0.02	0.18
dm ₁ female	Unrestored	105	6.93	.041	0.43		
	Restored	16	7.16	.078	0.31	-0.23	2.06 *
dm ₂ male	Unrestored	135	9.00	.044	0.51		
	Restored	19	9.04	.180	0.79	-0.04	0.29
dm ₂ female	Unrestored	105	8.91	.041	0.43		
	Restored	10	9.10	.181	0.57	-0.19	1.29
MANDIBLE							
dm ₁ male	Unrestored	113	7.82	.041	0.45		
	Restored	23	7.76	.090	0.43	-0.06	0.58
dm ₁ female	Unrestored	91	7.69	.042	0.42		
	Restored	16	7.79	.106	0.42	-0.10	0.91
dm ₂ male	Unrestored	129	9.84	.036	0.42		
	Restored	16	9.69	.108	0.43	0.15	1.30
dm ₂ female	Unrestored	102	9.73	.042	0.43		
	Restored	10	9.77	.091	0.29	-0.04	0.30

* Significant at the 5% level of confidence.

TABLE 7

Summary of 't' tests of the differences in mesio-distal tooth diameter between Unrestored and Restored teeth found in the NINE YEAR sample. "dm₁" is deciduous first molar and "dm₂" is deciduous second molar .

LEFT SIDE

		N	Mean in mm.	S.D. _m	S.D. _s	Diff.	't'
MAXILLA							
dm ₁	Unrestored	72	7.07	.052	0.44		
male	Restored	30	7.00	.084	0.46	.067	0.68
dm ₁	Unrestored	46	6.82	.056	0.38		
female	Restored	32	7.00	.086	0.49	-.177	1.80
dm ₂	Unrestored	75	8.90	.054	0.47		
male	Restored	36	8.83	.079	0.48	.075	0.78
dm ₂	Unrestored	47	8.70	.068	0.47		
female	Restored	43	8.73	.069	0.45	-.033	0.34
MANDIBLE							
dm ₁	Unrestored	74	7.03	.050	0.43		
male	Restored	24	7.13	.103	0.50	-.105	0.99
dm ₁	Unrestored	48	6.89	.053	0.37		
female	Restored	24	6.96	.115	0.57	-.065	0.58
dm ₂	Unrestored	70	8.97	.058	0.49		
male	Restored	29	8.77	.079	0.43	.202	1.94
dm ₂	Unrestored	52	8.76	.063	0.46		
female	Restored	25	8.78	.111	0.56	-.014	0.12

RIGHT SIDE

		N	Mean in mm.	S.D. _m	S.D. _s	Diff.	't'
MAXILLA							
dm ₁	Unrestored	62	7.81	.066	0.52		
male	Restored	36	7.74	.074	0.44	.062	0.60
dm ₁	Unrestored	38	7.57	.089	0.56		
female	Restored	38	7.70	.069	0.43	-.124	1.09
dm ₂	Unrestored	77	9.80	.057	0.50		
male	Restored	29	9.88	.095	0.53	-.075	0.68
dm ₂	Unrestored	47	9.60	.076	0.52		
female	Restored	33	9.70	.100	0.58	-.096	0.78
MANDIBLE							
dm ₁	Unrestored	60	7.85	.062	0.48		
male	Restored	26	7.85	.094	0.48	.003	0.03
dm ₁	Unrestored	37	7.60	.070	0.43		
female	Restored	28	7.63	.085	0.45	-.125	1.14
dm ₂	Unrestored	68	9.89	.058	0.49		
male	Restored	23	9.74	.092	0.44	.148	1.29
dm ₂	Unrestored	49	9.68	.078	0.55		
female	Restored	26	9.66	.095	0.48	.020	0.16

TABLE 8 Mesiodistal Crown Diameters of Unrestored, Non-carious Deciduous Teeth. No "antimere" or "unreliable" (see Table 4) measufes were used. LEFT SIDE

MAXILLA		N	MEAN (mm.)	S.D. _m	S.D. _s	C.V. %
di ₁	M	136	6.43	.032	0.38	5.9
	F	102	6.30	.039	0.39	6.2
di ₂	M	157	5.17	.027	0.33	6.4
	F	157	5.17	.027	0.33	6.4
dc	M	162	6.81	.030	0.39	5.7
	F	129	6.66	.028	0.34	5.1
dm ₁	M	133	7.11	.033	0.40	5.6
	F	107	6.89	.036	0.38	5.6
dm ₂	M	134	8.94	.040	0.47	5.2
	F	112	8.79	.039	0.41	4.7
MANDIBLE						
di ₁	M	93	3.40	.028	0.28	6.9
	F	52	3.95	.049	0.35	9.0
di ₂	M	153	4.58	.027	0.34	7.3
	F	114	4.56	.035	0.39	3.3
dc	M	165	5.75	.025	0.32	5.5
	F	127	5.73	.028	0.33	5.7
dm ₁	M	110	7.77	.042	0.45	5.8
	F	84	7.60	.047	0.43	5.7
dm ₂	M	128	9.90	.037	0.44	4.4
	F	100	9.73	.045	0.45	4.6

TABLE 9

Mesiodistal Crown Diameters of Unrestored, Non-carious Deciduous Teeth. No "antimere" or "unreliable" (see Table 4) measures were used.

		RIGHT SIDE					
		N	MEAN	(mm.)	S.D. _m	S.D. _s	C.V. %
MAXILLA							
di ₁	M	134	6.46		.033	0.39	6.1
	F	107		6.32	.039	0.40	6.4
di ₂	M	154	5.18		.027	0.33	6.3
	F	122		5.14	.032	0.36	7.0
dc	M	166	6.80		.032	0.41	6.0
	F	129		6.60	.032	0.37	5.6
dm ₁	M	130	7.08		.033	0.39	5.5
	F	105		6.93	.041	0.43	6.1
dm ₂	M	135	9.00		.044	0.51	5.7
	F	105		8.91	.041	0.43	4.8
MANDIBLE							
di ₁	M	88	4.05		.035	0.34	8.3
	F	51		3.99	.051	0.37	9.2
di ₂	M	149	4.57		.027	0.33	7.3
	F	110		4.57	.035	0.37	8.2
dc	M	161	5.77		.028	0.36	1.3 ?
	F	129		5.71	.027	0.31	5.3
dm ₁	M	113	7.82		.041	0.45	5.7
	F	91		7.69	.042	0.42	5.4
dm ₂	M.	129	9.84		.036	0.42	4.3
	F	102		9.73	.042	0.43	4.4

TABLE 10 Mesiodistal Crown Diameters of Unrestored, Non-carious Permanent Teeth measured in this investigation. No "antimere" or "unreliable" (see Table 5) measures were used.

LEFT SIDE

MAXILLA		N	MEAN (mm.)	S.D. _m	S.D. _s	C.V. %
I ₁	M	127	8.75	.045	0.51	5.85
	F	104	8.57	.048	0.50	5.79
I ₂	M	109	6.74	.045	0.48	7.06
	F	95	6.57	.064	0.63	9.59
M ₁	M	106	10.44	.052	0.54	5.16
	F	89	10.11	.050	0.48	4.74
MANDIBLE						
I ₁	M	130	5.49	.027	0.32	5.77
	F	106	5.36	.032	0.34	6.36
I ₂	M	124	6.00	.033	0.37	6.18
	F	106	5.91	.037	0.40	6.73
M ₁	M	74	11.05	.057	0.49	4.44
	F	58	10.60	.078	0.60	5.65

TABLE 11

Mesiodistal crown diameters of unrestored, non-carious permanent teeth measured in this study. No "antimere" or "unreliable" (see Table 5) measures were used.

RIGHT SIDE

		N	MEAN (mm.)	S.D. _m	S.D. _s	C.V. %
MAXILLA						
I ₁	M	128	8.84	.044	0.51	5.71
	F	104	8.61	.046	0.47	5.49
I ₂	M	115	6.79	.050	0.54	7.92
	F	98	6.61	.060	0.60	9.04
M ₁	M	102	10.42	.049	0.50	4.72
	F	84	10.14	.056	0.51	5.06
MANDIBLE						
I ₁	M	125	5.47	.025	0.29	5.30
	F	106	5.35	.033	0.34	6.41
I ₂	M	127	6.00	.030	0.36	5.91
	F	104	5.81	.039	0.40	6.91
M ₁	M	59	10.94	.069	0.53	4.85
	F	51	10.55	.078	0.56	5.28

TABLE 12 Means for arch length and tooth material for maximum data using filled, carious and opposite side teeth.

SIX YEAR

MALES

FEMALES

	N	MEAN (mm) ARCH TEETH	SD m	SD s	N	MEAN (mm) ARCH TEETH	SD m	SD s
MAX LEFT	165 143	37.00 34.51	.16 .13	2.01 1.52	129 113	36.17 33.97	.14 .14	1.62 1.45
MAX RIGHT	164 143	36.59 34.60	.14 .14	1.80 1.64	127 113	36.06 33.97	.16 .17	1.78 1.77
MAX ARCH MAX TEETH	164 143	73.57 69.11	.27 .26	3.51 3.08	127 113	72.26 67.94	.28 .29	3.19 3.11
MAND LEFT	165 138	33.73 32.63	.15 .13	1.95 1.50	128 108	33.14 32.43	.20 .16	2.22 1.65
MAND RIGHT	161 135	34.12 32.62	.14 .13	1.78 1.48	126 108	33.30 32.44	.16 .16	1.74 1.61
MAND ARCH MAND TEETH	161 135	67.83 65.23	.26 .25	3.35 2.92	126 107	66.43 64.87	.32 .31	3.59 3.20

NINE YEAR

MALES

FEMALES

	N	MEAN (mm) ARCH TEETH	SD m	SD s	N	MEAN (mm) ARCH TEETH	SD m	SD s
MAX LEFT	132 108	38.58 37.85	.16 .16	1.86 1.67	105 84	37.42 37.35	.19 .19	1.98 2.74
MAX RIGHT	132 108	38.35 38.07	.17 .17	1.98 1.76	105 84	37.33 37.55	.20 .18	2.06 1.69
MAX ARCH MAX TEETH	132 108	76.93 75.92	.31 .32	3.60 3.36	105 84	74.75 74.91	.37 .37	3.76 3.35
MAND LEFT	132 100	34.47 34.97	.18 .19	2.11 1.87	105 73	34.02 34.26	.20 .18	2.00 1.55
MAND RIGHT	131 99	34.67 34.99	.21 .14	2.40 1.43	105 71	33.64 34.27	.21 .19	2.16 1.58
MAND ARCH MAND TEETH	131 99	69.15 69.98	.35 .31	3.99 3.12	105 71	67.66 68.55	.37 .37	3.82 3.08

TABLE 13 Means for arch length and tooth material using data computed from arches containing no missing or restored teeth.

SIX YEAR		MALES					FEMALES				
		N	ARCH	MEAN (mm)	SD _m	SD _s	N	ARCH	MEAN (mm)	SD _m	SD _s
				TEETH					TEETH		
MAX LEFT	74	74	37.08		.24	2.09	59	35.99		.20	1.52
	74			34.58	.19	1.61	59		33.84	.18	1.36
MAX RIGHT	74	74	36.64		.20	1.75	59	35.89		.21	1.58
	74			34.63	.20	1.71	59		33.91	.20	1.50
MAX ARCH MAX TEETH	74	74	73.71		.40	3.41	59	71.87		.39	2.99
	74			69.21	.38	3.28	59		67.75	.37	2.82
MAND LEFT	74	74	33.70		.27	2.30	59	33.08		.31	2.41
	74			32.58	.19	1.64	59		32.16	.22	1.67
MAND RIGHT	74	74	34.28		.19	1.67	59	33.21		.25	1.89
	74			32.56	.19	1.61	59		32.17	.22	1.68
MAND ARCH MAND TEETH	74	74	67.97		.39	3.36	59	66.30		.50	3.87
	74			65.14	.37	3.20	59		64.32	.43	3.31

NINE YEAR		MALES					FEMALES				
		N	ARCH	TEETH	SD _m	SD _s	N	ARCH	TEETH	SD _m	SD _s
MAX LEFT	30	30	39.24		.33	1.83	20	38.03		.34	1.53
	30			38.31	.29	1.56	20		37.64	.34	1.52
MAX RIGHT	30	30	38.85		.28	1.55	20	37.80		.35	1.58
	30			38.57	.30	1.66	20		37.91	.35	1.56
MAX ARCH MAX TEETH	30	30	78.09		.60	3.26	20	75.83		.63	2.83
	30			76.88	.58	3.18	20		75.55	.69	3.06
MAND LEFT	30	30	34.82		.43	2.34	20	34.46		.32	1.44
	30			34.85	.33	1.83	20		34.52	.38	1.71
MAND RIGHT	30	30	35.31		.26	1.40	20	34.44		.42	1.88
	30			35.04	.32	1.75	20		34.60	.36	1.60
MAND ARCH MAND TEETH	30	30	70.13		.56	3.08	20	68.90		.72	3.23
	30			69.89	.64	3.53	20		69.12	.73	3.26

TABLE 14

Average spacing - crowding values for maximum data using restored, carious and opposite side teeth. A plus value indicates spacing to the extent of the associated value. A negative value indicates crowding.

SIX YEAR	MALES				FEMALES			
	N	Mean in mm.	S.D. _m	S.D. _s	N	Mean in mm.	S.D. _m	S.D. _s
MAX LEFT	143	2.65	0.14	1.64	113	2.22	0.12	1.23
MAX RIGHT	142	2.13	0.14	1.67	112	2.06	0.15	1.62
MAXILLA	142	4.76	0.25	2.93	112	4.29	0.24	2.56
MAND LEFT	138	1.17	0.15	1.75	108	0.67	0.23	2.37
MAND RIGHT	135	1.63	0.14	1.68	108	0.86	0.17	1.74
MANDIBLE	135	2.80	0.25	2.93	107	1.51	0.36	3.69

NINE YEAR	MALES				FEMALES			
MAX LEFT	108	0.88	0.15	1.57	84	0.43	0.13	1.20
MAX RIGHT	108	0.51	0.13	1.40	84	0.13	0.17	1.55
MAXILLA	108	1.39	0.26	2.65	84	0.56	0.27	2.49
MAND LEFT	100	0.01	0.18	1.81	73	0.08	0.20	1.74
MAND RIGHT	99	0.24	0.18	1.74	71	-0.23	0.16	1.38
MANDIBLE	99	0.24	0.28	2.77	71	-0.12	0.30	2.55

TABLE 15

Average spacing - crowding values for data computed from arches containing no missing or restored teeth. A plus value indicates spacing and a negative value indicates crowding.

SIX YEAR		MALES			FEMALES			
	N	Mean in mm.	S.D. _m	S.D. _s	N	Mean in mm.	S.D. _m	S.D. _s
MAX LEFT	74	2.50	0.22	1.87	59	2.14	0.15	1.16
MAX RIGHT	74	2.00	0.21	1.79	59	1.97	0.19	1.44
MAXILLA	74	4.50	0.37	3.15	59	4.12	0.31	2.42
MAND LEFT	74	1.12	0.25	2.13	59	0.93	0.35	2.65
MAND RIGHT	74	1.72	0.22	1.92	59	1.05	0.26	2.01
MANDIBLE	74	2.83	0.40	3.43	59	1.98	0.55	4.25

NINE YEAR		MALES			FEMALES			
	N	Mean in mm.	S.D. _m	S.D. _s	N	Mean in mm.	S.D. _m	S.D. _s
MAX LEFT	30	0.93	0.27	1.49	20	0.39	0.20	0.89
MAX RIGHT	30	0.28	0.27	1.46	20	-0.11	0.26	1.17
MAXILLA	30	1.21	0.50	2.76	20	0.28	0.38	1.70
MAND LEFT	30	-0.03	0.41	2.26	20	-0.06	0.33	1.48
MAND RIGHT	30	0.27	0.22	1.20	20	-0.16	0.26	1.15
MANDIBLE	30	0.24	0.54	2.94	20	-0.22	0.54	2.42

TABLE 16

Summary of error control study for the variables listed. Every 30th set of casts was measured twice and the second measurement subtracted from the first.

			N	Mean difference in mm.	SD m	't'
OVERJET I			20	.080	.076	1.05
OVERJET II			20	.120	.063	1.90
MOLAR RELATIONSHIP	LEFT		20	.015	.135	.11
	RIGHT		20	.090	.085	1.06
CUSPID RELATIONSHIP	LEFT		19	.015	.098	.15
	RIGHT		19	.342	.335	1.02
MIDLINE			18	.138	.071	1.94
OVERBITE			20	.030	.103	.29
ARCH LENGTH	MAXILLARY		20	.450	.493	.91
	MANDIBULAR		20	.075	.044	1.70
ARCH WIDTH	MAX.	MOLAR	20	.000	.047	.00
		CUSPID	20	.031	.030	1.03
ARCH WIDTH	MAND.	MOLAR	20	.050	.063	.79
		CUSPID	18	.027	.042	.64
PALATE DEPTH			20	.120	.210	.57

TABLE 17

Summary of the mean values for the various arch relationship measures made for the SIX YEAR group.

		N	Mean (mm.)		SD _m	SD _s
OVERJET I	M	131	2.99		.104	1.20
	F	106		2.93	.140	1.44
OVERJET II	M	130	0.42		.095	1.08
	F	106		0.70	.147	1.51
MOLAR LEFT RELATIONSHIP RIGHT	M	158	-0.01		.117	1.47
	F	123		-0.02	.108	1.20
	M	156	0.38		.119	1.49
	F	125		0.16	.100	1.12
CUSPID LEFT RELATIONSHIP RIGHT	M	165	1.24		.116	1.50
	F	130		1.17	.110	1.26
	M	167	1.58		.115	1.49
	F	130		1.39	.111	1.27
MIDLINE	M	139	0.01		.060	0.72
	F	112		0.09	.083	0.88
OVERBITE	M	131	1.62		.105	1.20
	F	103		1.34	.126	1.28
ARCH LENGTH MAX MAND	M	150	28.37		.166	2.03
	F	116		27.84	.147	1.58
	M	151	25.84		.151	1.86
	F	123		25.25	.143	1.59
ARCH WIDTH CUSPID MAXILLA	M	166	41.17		.156	2.01
	F	127		40.08	.194	2.19
	M	166	29.52		.156	2.01
	F	130		28.87	.160	1.83
ARCH WIDTH CUSPID MANDIBLE	M	163	37.35		.153	1.95
	F	127		36.35	.207	2.34
	M	165	23.69		.191	2.45
	F	129		23.37	.173	1.96
PALATE DEPTH	M	160	15.67		.149	1.89
	F	124		14.99	.146	1.63

TABLE 18

Summary of the mean values for the various arch relationship measures made for the NINE YEAR group.

		N	Mean (mm.)		SD _m	SD _s
OVERJET I	M	134	4.13		.149	1.72
	F	107		3.72	.140	1.45
OVERJET II	M	134	0.95		.135	1.57
	F	108		1.18	.146	1.52
MOLAR LEFT RELATION- SHIP RIGHT	M	135	1.09		.156	1.82
	F	106		0.92	.160	1.65
	M	135	1.66		.159	1.85
	F	116		1.20	.164	1.69
CUSPID LEFT RELATION- SHIP RIGHT	M	123	1.11		.149	1.66
	F	92		0.70	.153	1.46
	M	121	1.27		.163	1.79
	F	94		0.89	.170	1.65
MIDLINE	M	134	0.22		.084	0.97
	F	106		0.28	.105	1.09
OVERBITE	M	134	3.26		.112	1.30
	F	107		2.63	.153	1.58
ARCH MAX MAND LENGTH	M	135	30.24		.174	2.02
	F	108		29.55	.234	2.44
	M	135	26.36		.193	2.25
	F	108		25.72	.185	1.92
ARCH MOLAR WIDTH CUSPID MAXILLA	M	137	42.73		.188	2.20
	F	108		41.38	.257	2.67
	M	124	32.11		.168	1.87
	F	93		31.20	.183	1.77
ARCH MOLAR WIDTH CUSPID MANDIBLE	M	135	38.01		.188	2.19
	F	108		37.14	.223	2.31
	M	118	26.31		.187	2.03
	F	90		25.56	.210	1.99
PALATE DEPTH	M	135	17.06		.164	1.91
	F	105		16.37	.179	1.84

TABLE 19

This table presents correlations between some of the arch relationship and arch dimension variables for the SIX YEAR OLD GROUP.

Correlations		MALES		FEMALES	
		N	r	N	r
Overjet I &	Overjet II	42	.768*	43	.921*
	L. Molar Relationship	41	.453*	40	-
	R. Molar Relationship	58	-	41	.495*
	L. Cuspid Relationship	41	.245	43	.580*
	R. Cuspid Relationship	42	.528*	43	.668*
	Overbite	41	.165	42	.002
	Max. Arch Length	42	.266	42	.394*
	Mand. Arch Length	41	.063	43	.195
L. Molar & Relationship	R. Molar Relationship	66	.501*		
	L. Cuspid Relationship	47	.734*		
	R. Cuspid Relationship	48	.517*		
	Overbite	41	.440*		
	Max. Arch Length	45	-.214		
	Mand. Arch Length	45	-.024		
R. Molar & Relationship	L. Cuspid Relationship	50	.414*	48	.671*
	R. Cuspid Relationship	51	.574*	48	.658*
	Overbite	43	.142	40	.377*
	Max. Arch Length			42	-.089
	Mand. Arch Length			46	.029
L. Cuspid & Relationship	R. Cuspid Relationship	49	.598*	50	.810*
	Overbite	41	.251	42	.058
	Max. Arch Length	45	-.009	44	.083
	Mand. Arch Length	46	.082	48	.207
R. Cuspid & Relationship	Overbite	42	.206	42	.117
	Max. Arch Length	46	-.062	44	.140
	Mand. Arch Length	46	-.006	48	.225
Max. Arch Length & Mand, Arch Length		44	.376*	42	.744*
* Correlation significant at 5% level of confidence.					

TABLE 20 Correlations between some of the arch relationship and arch dimension variables for the NINE YEAR OLD GROUP.

Correlations	MALES		FEMALES	
	N	r	N	r
Overjet I & Overjet II	30	.81 *	30	.77 *
& L. Molar Relationship	30	.25	30	.38 *
R. Molar Relationship	30	.19	30	-.02
L. Cuspid Relationship	24	.68 *	23	.65 *
R. Cuspid Relationship	23	.67 *	25	.72 *
Overbite	30	.20	30	.14
Max. Arch Length	30	.40 *	30	.34
Mand. Arch Length	30	.08	30	.12
L. Molar Relationship & L. Cuspid Relationship	30	.52 *	30	.13
ship R. Cuspid Relationship	24	.56 *	23	.46 *
Overbite	23	.34	25	.24
Max. Arch Length	30	.22	30	.09
Mand. Arch Length	30	.00	30	.06
R. Molar Relationship & R. Cuspid Relationship	30	.49 *	30	.02
ship Overbite	24	.16	23	.15
Max. Arch Length	23	.47 *	25	.30
Mand. Arch Length	30	.15	30	-.03
L. Cuspid Relationship & Overbite	30	-.39 *	30	-.59 *
ship Max. Arch Length	30	.19	30	-.10
L. Cuspid Relationship & Overbite	24	.74 *	22	.82 *
ship Max. Arch Length	24	.17	23	-.22
Mand. Arch Length	24	.40 *	23	-.07
R. Cuspid Relationship & Overbite	24	.23	23	-.31
ship Max. Arch Length	23	.25	25	.08
Mand. Arch Length	23	.28	25	.03
Max. Arch Length and Mand. Arch Length	23	.22	25	.28
Max. Arch Length and Mand. Arch Length	30	.50 *	30	.69 *

* Correlation significant at 5% level of confidence.

TABLE 21 A few examples of correlations between the spacing-crowding values (Table 14) and some arch relationship values. To date, the correlations have been computed only for the maxillary quadrants of the SIX YEAR OLD GROUP.

Correlations		MALES		FEMALES	
		N.	r	N	r
Spacing-crowding in the Max. Left Quadrant &	Overjet I	42	.27	59	.13
	L. Molar Relationship	44	-	64	-
	R. Molar Relationship	45	-.08	65	-.21
	L. Cuspid Relationship	44	-.15	66	.04
	R. Cuspid Relationship	45	-.23	66	-.06
	Overbite	42	-.03	58	-.29*
Max. Right Quadrant &	Overjet I	41	.25	59	-.17
	L. Molar Relationship	43	-	64	-
	R. Molar Relationship	44	-.16	65	-.37*
	L. Cuspid Relationship	43	-.16	66	-.27*
	R. Cuspid Relationship	44	.14	66	-.24
	Overbite	41	-.07	58	-.12

* Correlation significant at 5% level of confidence.

APPENDIX A

(Data File 46)

All of the measurements made on the plaster casts for the six and nine year age groups of the control sample are on punched cards in 20 word - 4 digit format, suitable for processing by special programs, on the IBM 650 computer. Programs now available include a basic standard deviation routine, a 't' test program and a summing routine for the computation of spacing-crowding.

The data cards are kept in Room 506 at the Faculty of Dentistry, 124 Edward Street, Toronto. While it is intended that these be available to all, it should be understood that this master set of cards is to be used only for the purpose of reproducing a 'working' set of cards and should be returned immediately to Room 506 in the order in which they were found.

BURLINGTON ORTHODONTIC RESEARCH CENTRE

PROGRESS REPORT SERIES

No. 6

1960 - 1961

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TORONTO

Division of Dental Research
Faculty of Dentistry
University of Toronto, 1961

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I Annual Meeting Agenda

Burlington Orthodontic Research

Division of Dental Research

Faculty of Dentistry

University of Toronto

November 29, 1961

1. Chairman's Remarks -
Dr. Gordon Nikiforuk, Chairman of Division of Dental Research
2. Summary of 1961 work -
Dr. M. E. Hatton, Research Fellow
3. Comments on Analysis of Orthodontically Supervised Children -
Dr. S. Hunter, Consultant
4. Future Plans -
Dr. R. M. Grainger, Director
5. Comments on Applications of Findings in Dental School -
Dean R. G. Ellis
6. General Discussion
7. Adjournment

II ADMINISTRATION AND STAFF

Staff Changes. This year four senior staff members have resigned from the project. At the end of June, Dr. Egil Harvold, the director for the last two years was appointed to head the Orthodontic Department in a new dental school in Scandinavia thus terminating his Canadian residency and connection with the research project. Fortunately his services are not altogether lost and he will continue some of the studies he commenced and communicate the results from Europe. Dr. Stuart Hunter also left in June to take a full time post in the Orthodontic Department at the University of Michigan. He will, however, continue active participation as consultant through the generosity of the University of Michigan which has offered to send Dr. Hunter up to Burlington at frequent intervals. Dr. Wilfred Feasby resigned from the staff to become head of the Pedodontic Department at the University of Manitoba. Dr. Robert Boyko has left the project to devote full time to his private practice of Orthodontics.

Dr. Frank Popovich, the project director for the initial years, is welcomed back on the staff after a two year leave of absence. Two new orthodontic staff appointments are Doctors Robert Hamilton and Peter Peloso. As a research consultant Dr. R. M. Grainger has been associated with the project since its beginning and since July the first, has assumed the direction of the project with his time being donated by the Research Division of the Dental Faculty.

The continued support of the part time clinical staff whose services are given to the clinic at personal financial loss from their practices is greatly appreciated and acknowledged.

Clinic Staff for 1961-62

<u>Position</u>	<u>Name</u>	<u>Time</u>
Research Fellow and Clinic Administrator	Margaret Hatton B.A., Ph.D.	Full time.
Orthodontists	Allen Feldman, D.D.S.	1/2 day per week
	Albert Jarvis, D.D.S., M.Sc.	1/2 " " "
	C. Bruce Morrow, D.D.S., M.Sc.	1 " " "
	Frank Popovich, D.D.S., M.Sc.	1/2 " " "
	Peter Peloso, D.D.S., M.Sc.	1/2 " " "
	Robert Hamilton, D.D.S., M.Sc.	1/2 " " "
Pedodontist	Lorne Scott, D.D.S.	1/2 " " "
Orthodontic Technician and Secretary	Mrs. Margaret Holbrook	Full time
Orthodontic Assistant and Stenographic-Receptionist	Mrs. Katharine Scarlett	Full time
Logatronic Technician	Mrs. L. Rynning	Full time

Faculty Staff

Dean R. G. Ellis	- Grantee
Dr. Gordon Nikiforuk	- Chairman of Research Division, Faculty of Dentistry, Grant Fund Administrator and Advisor
Dr. R.M. Grainger	- Statistician, Faculty of Dentistry, Project Director.
Dr. D. Woodside	- Head of Orthodontic Department, University of Toronto
Dr. J. Anderson	- Anthropologist, University of Toronto

III EXTRAMURAL ACTIVITIES 1960 - 1961

1. Dr. Grainger attended the Annual Meeting of the International Association of Dental Research which was held in Boston in March. He presented a paper entitled, "Interrelations of Malocclusion Manifestations and Etiologic Factors." This paper is to be published in the Journal of Pedodontics.
2. This paper was also read at the meeting of the Toronto chapter of the organization in December, 1960.
3. Doctors Egil Harvold and Margaret Hatton attended the Boston meeting of the I.A.D.R. and their paper, "Cranio-facial Characteristics as Predisposing Factors in the Development of Malocclusion" was selected to be presented along with three others at the joint session held for researchers and teachers at the meeting. This paper has since been accepted for publication in the Journal of Dental Research.
4. This paper was also presented at the meeting of the Toronto chapter of the organization in January, 1961.
5. A paper "The Burlington Orthodontic Research Centre: A Measure of its Role in Dental Public Health" by Doctors Egil Harvold and Margaret Hatton has been accepted for publication by the Journal of the Canadian Dental Association.
6. Dr. Stuart Hunter read a paper entitled "Crowding - Spacing" at the Toronto chapter of the I.A.D.R. in March, 1961.

IV STATUS OF CASE RECORDS

Records on Hand

Group	Sex	Age nearest Birthday																	1 t s
		3	4	5	6	7	8	9	10	11	12	14	16	17	18	19			
Serial Treated	F	102	137	133	131	127	121	121	95#	39#	-#	-							
	M	135	166	160	154	149	143	141	97#	35#	1#								
Serial not Treated (original 6 Years)	F	-	-	-	130	-	-	109	-	-	85#						#		
	M	-	-	-	169	-	-	141	-	-	106#						#		
Serial not Treated	F	-	-	-	-	-	-	-	107	-	-						16#		
	M	-	-	-	-	-	-	-	121	-	-						11#		
Cross- sectional not Treated	F							125									#		
	M							99									#		
	F												101						
	M												114						
Pedigree Study																			
Twins## (pairs)	F)	3	5	6	11	5	12	8	1	3	13	2							
	M)																		
Siblings	F	57	87	90	129	87	121	118	77	34	48	17	6	2	0	1			
	M	61	95	93	143	97	116	126	90	31	53	11	6	1	1	1			
Parents	F																		
	M																		

Sample groups for which records are outstanding in part or whole.

Twin pairs of all three combinations are included here. The twin sample is also included in the sibling material shown.

In order to bring the serial treatment group up to their 12th birthday and to obtain records of 16 year olds which are needed to round out the growth study data the following time table is to be followed:

Group	Sex	1961 age			1962 age			1963 age			1964 age			Total
		10	11	12	10	11	12	10	11	12	10	11	12	
Serial treatment	F	0	1	1	3	61	47	0	3	61	0	0	3	180
	M	9	4	0	1	81	56	0	1	81	0	0	1	233
Serial not-treated (original 6 yrs.)		<u>age 12</u>												
	F			15										15
	M			30										30
(original 8 year olds)		<u>age 16</u>												
	F			125										125
	M			99										99
Original 6 years	F										106)			
	M										) 1966 138)			
Pedigree Study 1962 - 1963														
Parents	F			63										63
	M			67										67
Siblings#	F			59										59
	M			63										63
Totals													934	

Thus it may be seen that roughly 1,000 records are to be gathered during the next two years.

The total number of siblings to be seen during the next 18 months is approximately 122. This includes children between the ages of 8 and 16 years.

V STATUS OF TREATMENT CASES

The number of cases in the serial group under active treatment at present are by age:

Age	Male	Female	Total
9	2	2	4
10	64	36	100
11	28	24	52
12	1	0	1
Total			157

Terminal Treatment Load

With the objective of terminating the major phases of the project by March 1963 (it is probable some few cases will of necessity require longer treatment to fulfill the obligation to the public) a method of establishing the treatment priority has been developed and is under test.

The Burlington project has been a public health study aimed at testing interceptive treatment and exploring methods which could be taught to practicing dentists who are not orthodontic specialists. Thus of necessity the level of individual case perfection aimed at is not the same as that which would be forthcoming from the office of a specialist and hence a considerable number of cases with small non-handicapping defects will be discharged without further treatment. Those children who have defects which may be considered handicapping and which have not been satisfactorily resolved over the test period are to be completed by the staff using major appliance therapy where needed.

Preservation of Records for Future Study

Housing. At the termination of the active phase in 1963 the data will be permanently housed in Room 506, Dental Faculty, University of Toronto, where it will be available under the control of the faculty research committee as reference data. Plans are underway to duplicate the entire set of records so that one set will be kept in reserve storage in case of damage to the library set. A librarian (or technician) will be in charge of issuing data from the files and replacing data in the files. This librarian will also be responsible for maintenance of the data (replacement of soiled covers, repair of models etc.).

Availability for Study

All studies must meet approval of the Research Committee of Faculty. No data may be removed from the reference room but copies which will be produced at the expense of the research worker may be removed until termination of the study at which time these copies become the property of the Faculty.

All measurements, recordings, produced either by independent workers or the main project, etc. are to be catalogued and punched on I.B.M. cards for use in future investigations. All such data are the property of the Faculty not the research worker who has been permitted to make the measurements and use them for an approved study.

The present moratorium on the data is lifted (effective as soon as library arrangements are completed) on the single control record sets at ages 8, 10 and 12 years. Students in the medical, anthropology and dental fields are invited to apply if interested in this data. The serial control and serial treatment groups will remain frozen until the final reports on the main project have been completed to avoid overtaxing the facilities of the Burlington Clinic where the cases are under active use.

It has been realized that the problem of establishing the treatment priority of the children in Burlington is very similar to that which would be faced in organizing a pre-paid dental insurance scheme which included orthodontics. Whereas it has been shown that about 70% of the Burlington children do not have perfect occlusion only a fraction of these defects would be considered handicapping in the public health sense. However the graduation of handicapping from the most serious cases to those obviously minor is quite gradual and it has been decided to determine the cut-off point in terms of a treatment priority score or index.

Treatment Priority Index

Malocclusion in the public health sense is any deviation from the accepted norm to the extent that the person is handicapped in one or more of the following ways:

- (1) Esthetics is poor.
- (2) Function is poor, either in the sense of reduced masticatory efficiency, reduced speech clarity, or difficult feeding in the case of infants.
- (3) Traumatic injury through food impaction, unequal distribution of chewing forces on certain teeth, or direct interference of teeth with soft tissue is likely serious enough to cause periodontal disease or uncontrollable tooth decay.
- (4) Gross surgical defects such as cleft palate are present.

With the above in mind a group of measurements which have become standard in the Burlington study and which can be made either on models or the actual person were selected. These are shown in the

following preliminary work sheet. A warning is necessary, the measurements on the preliminary form were designed so that they could be easily obtained without special equipment and so that they would be as objective and reproduceable as possible. The individual observation scores do not reflect the importance of the individual measurements in reflecting the degree of handicap nor can the sum of these scores be expected to yield an acceptable priority score. The working index is to be a weighted sum of the observation scores. The weights are being computed by multiple regression so that the best estimate of a clinical assessment will be reached. For general public health practice the weights would be to some extent age specific but in the Burlington project they are derived from analysis of the 12 year control sample. The finished weights are unavailable at the time of writing but it is hoped they will be available as an addendum at the time of the annual meeting.

PRELIMINARY ORTHODONTIC TREATMENT PRIORITY SCORE

Name	Serial No.	Age	Sex
------	------------	-----	-----

Antero-Posterior
Molar Relation

Left Right

D M D M

Normal

0 0 0 0

Less than cusp to cusp

2 2 2 2

More than cusp to cusp

4 4 4 4

Anterior Crossbite Number of teeth 0, 1, 2, 3, 4

Posterior Crossbite: Number of teeth - L - 0, 1, 2, 3, 4, 5, 6
- R - 0, 1, 2, 3, 4, 5, 6

Incisor Overjet: Millimeters

Overbite: $1/3 = 0$, $1/3$ to $2/3 = 1$, $2/3$ to $3/3 = 3$, Below Margin 4

Openbite: Millimeters

Spacing ($\frac{1}{2}$ width of four Lower (Ant. (distol of lat. to
Factor: Incisors in mm.) overlap) mes. of molar)

(Left..... + 11 mm) - () - () =

Upper $\left\{ \begin{array}{l} \text{(Right + 11 mm) - (.....) - (.....) =} \end{array} \right.$

(Left + 10 mm) - () - () =

Lower $\left\{ \begin{array}{l} \text{(Right..... + 10 mm) - (.....) - (.....) =} \end{array} \right.$

Diastema: Millimeters

Individual teeth: Rotation	$< 45^{\circ}$	1	1	1	1
----------------------------	----------------	---	---	---	---

Rotation	$>45^{\circ}$	2	2	2	2
----------	---------------	---	---	---	---

Displacement < 1.5 mm.	1	1	1	1
--------------------------	---	---	---	---

Displacement >1.5 mm.	2	2	2	2
-----------------------	---	---	---	---

Congenital Cleft Palate		Hare Lip
-------------------------	--	----------

Gross Traumatic Pathology
describe

Caries: Resistant 2 Low 1 High -1 Rampant -2

Co-operation & Interest:	Good	2	Fair	0	Poor	-2
--------------------------	------	---	------	---	------	----

Periodontal Condition:	Good	2	Fair	0	Poor	-2
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Constitutional Disease:

Special Considerations:

Clinical Estimate of Priority: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

This Report was prepared by M. E. Hatton

According to the original frame of reference, the project is approaching its final stages with respect to the collection of records and the treatment programme. The material which has now been accumulated readily facilitates investigations aimed at calculating the relative efficacy of preventive-interceptive measures. To this end, the studies which have been undertaken during the past two years fall into two main types. First, there are those which attempt to clarify the possible relation among various cranio-facial components at different age levels in representative untreated serial and cross-sectional samples; second, those which are direct evaluations of possible differences between a serial sample of cases which has been subjected to preventive-interceptive procedures, and similar samples, both serial and cross-sectional, which received no such treatment. The significance of the first type of investigation lies in the fact that unless the natural changes in the maturation of the cranio-facial complex are clearly understood, no reliable, nor conclusive evaluation of preventive-interceptive procedures may be established. Of the second type of study it may be said that these provide answers to some quite relevant problems in dental public health. Are there certain cranio-facial characteristics that act as predisposing factors in malocclusion? What is the frequency (in a representative sample) with which children at various ages are afflicted with defects? How do these defects behave with age, not only in cross-sectional samples, but in the same children? How do these defects behave if subjected to early therapy? How does this early therapy affect the population?

In his detailed and expensive study on the dentition, Hunter not only described the characteristics of the teeth in serial untreated children, but also compared and contrasted these same characteristics in serial treated individuals. Like Hunter, Feldman described the same dental characteristics in the twelve year old control sample.

To determine whether or not certain skeletal features predispose an individual to developing a malocclusion was the aim of the initial study by Harvold and Hatton. This study served to clarify maturational changes in certain cranio-facial components and also indicated the possible relation among a number of these components. It also brought into focus the relative roles of form and function and their effects on occlusion. In the second part of this investigation, comparisons have been made not only of skeletal features in treated and untreated samples but also the frequency of certain malocclusion manifestations in the different groups.

VII Cranio-Facial Characteristics as Predisposing Factors in the Development of Malocclusion

Investigators: E. P. Harvold and M. E. Hatton

An evaluation of the relative merit of preventive measures creates the basic aim of the project and thus to clarify the characteristics of cranio-facial growth as the individual passes from infancy to adulthood is of prime importance. Questions as to the nature of symptoms of a real orthodontic problem as opposed to symptoms of a passing phase in maturation can only be answered if the changing relation of the various components of the facial complex are understood. The effects of preventive-interceptive measures rests squarely on this knowledge.

From the point of view of dental public health the immediate questions may be summarized as follows:-

1. Do certain cranio-facial characteristics occur with greater or lesser frequency in this population?
2. Are certain of these facial characteristics associated with malocclusion? That is to say, do certain traits predispose an individual to a malocclusion?
3. As maturation progresses, can sex differences be identified in characteristics of occlusion?
4. What is the frequency of malocclusion at the different age levels, or at different stages of maturation?
5. What is the mode of inheritance of certain cranio-facial characteristics?
6. If certain traits can be recognized as symptoms of real problems, what are the best practical preventive-interceptive measures?
7. Are there in fact certain types of growth patterns which may be described as transcending preventive-interceptive measures?
8. What is the frequency of this latter type (7), and also of (6)?

The first three of these eight questions will be considered here, the fourth question is the subject of the paper on page 24 of the present report.

Material - The samples on which this investigation was conducted include the cross-sectional untreated controls, four groups of children aged six, eight, ten and twelve years. These cases have received no preventive-interceptive therapy at the Center.

Method - Using lateral cephalograms, measurements were made first, of profile angle (Fig. 1,) nasion, subnasale, pogonion; second, of the difference between the bony base of the lower incisors (supramentale) and that of the upper incisors (subnasale) projected on to the functional occlusal plane (Fig. 1), and called A-B difference. The word functional is of particular significance here and for this reason deserves comment.

The Significance of the Functional Occlusal Plane

Although this particular investigation was aimed at analysing the morphological features of the cranio-facial complex and their possible bearing on occlusion, nevertheless, since occlusion is the outcome of morphology and muscle activity, the effects of the latter must also be given due consideration. Although morphology may be a contributing factor in malocclusion it is only one side of the picture. The explanation lies in the fact that the mandible is slung by muscles from certain fixed bones of the skull and face, so that the level at which the teeth align themselves, that is, their occlusal inclination is not only the outcome of skeletal formation and the eruptive process, but also, the result of muscle activity and jaw movement. The level of the occlusal plane must, therefore, be properly regarded as a resultant or end product of eruption, and the bone-muscle system. Indeed, clinical observation can provide substantial evidence to illustrate the powerful effects of the neuro-muscular reflexes. It is not uncommon for a case with a normal occlusion to change quite dramatically into one with a marked malocclusion and this with virtually no change in skeletal morphology. Thus, because of the nature of

the masticatory apparatus, occlusion can only correctly be considered in the light of form and function and it is for this reason that the occlusal plane used in this study, is referred to as the functional occlusal plane. Its significance lies in the fact that it reflects or is sensitive to not only changes in facial morphology, but also changes in muscle activity. It is a line drawn along the occlusal surfaces of only the molars and pre-molars which have an unrestricted eruption and which have occlusal contacts with their antagonists.

The attitude that aims at solving problems of occlusion through various skeletal analyses may be criticised on the grounds that morphology, per se, supplies rather inadequate information. The morphologic characteristics of the cranio-facial complex and changes that accompany growth take on proper meaning only when due consideration is paid to their biological significance.

Analysis of the Data

In addition to the two cranio-facial traits, profile angle and the A-B difference, taken from cephalograms, two dental characteristics, crowding and antero-posterior dental arch relation, were obtained from the models. Crowding here included lack of space for tooth material present in any one or more of the quadrants of the arch.

Frequency distributions of profile angle are shown in Figures 2 and 3.[#] As might have been expected, the angle increases in size as the jaws grow downwards and forwards. Although the central tendency for profile angle for boys and girls is much alike at all four age levels, the upper limits of the ranges, except at age ten years, are consistently greater for boys.

Frequency distributions for A-B difference are shown in Figures 4 and 5.[#] The range in this characteristic for boys and girls at all four age # - see published paper appended

levels is considerable. But perhaps the most significant feature to be noted is the change in the means for this characteristic for the different age groups. This mean value is smallest in both girls and boys at twelve years. On the other hand, profile angle increases between six and twelve years. Thus, although the jaws are actually growing downwards and forwards with the mandible becoming more protrusive, the effect of function more than compensates for this forwardly directed growth, in as much as the inclination of the occlusal plane is altered and with it, a change in the A-B relation is brought about. Indeed, B point does not fall in a more anterior position to A, but instead is placed in a more posterior position.

When the two characteristics, profile angle and A-B difference are tested for possible correlation, the results obtained (Table I) indicate that there is a positive correlation between the two at all four age levels in both boys and girls; concave-type profiles generally have mandibular protrusion of the alveolar process, whereas convex-type profiles are the reverse. Furthermore, as age increases, the correlation values increase, this would suggest that as maturation progresses, muscle patterns become more stable and this in turn is related to the changes in the eruptive process.

When the two common malocclusion manifestations, crowding and antero-posterior dental relation were related to measures of A-B difference, the results derived from chi-square analyses were those shown in Table II. It may be noted that there appears to be a real association between crowding and an A-B difference smaller than the means at age ten years in both boys and girls; dental distocclusion and smaller than average A-B relation are associated at all age levels except in girls at ten years. A difference in the growth pattern of the mandible between boys and girls at this age

level has also been observed in another study.

Finally tests were made to determine whether or not certain profiles were significantly associated with these two types of malocclusion. The limits for the values of the profile angles for the chi-square analyses were based on the mean values. The results are shown in Table III. These indicate that except at age twelve years in boys, crowding has no significant association with the profile. However, boys at eight years and girls at eight and twelve years all showed some relation between the profile and antero-posterior dental relation. Profile angles, less than the mean size, were significantly more frequently associated with dental distocclusion.

SUMMARY

Two features of the cranio-facial skeleton, profile angle, and A-B relation (the relation between the upper and the lower alveolar processes projected on to the functional occlusal plane) have been analysed in four representative groups of children, six, eight, ten and twelve years of age.

- The frequency with which these two traits occur in the population has been expressed in histograms; the mean values and their standard deviations have also been determined.
- In both boys and girls at all four age levels, the two traits have been shown to be positively correlated.

Two common malocclusion manifestations, crowding and distocclusion, were tested for possible association with A-B relation; crowding was found to be independent of this trait, except at age ten years. On the other hand, except at age ten years in females, distocclusion was significantly associated with smaller than average A-B relation.

Finally it was abundantly clear that whereas crowding of the teeth and profile angle are unrelated (except at age twelve in boys), on the other hand, smaller than average profile angles are predisposed to developing distocclusion of the teeth.

CONCLUSIONS

This study, aimed at evaluating cranio-facial features as predisposing factors in the development of malocclusion is of two-fold significance. First, results obtained serve to substantiate the view that although facial morphology has a bearing on occlusion it must properly be regarded as only one of two contributing factors. The effect of muscle activity on the functional occlusal plane is not inconsiderable and it too must be reckoned with. Second, the information on morphological features derived from this study of an untreated (orthodontically) group of children constitutes the base line with which similar observations derived from a treated (preventive-interceptive orthodontic therapy) group of children will be compared.

Note - This report is composed of portions taken from the paper entitled "The Burlington Orthodontic Research Centre: A Measure of Its Role in Dental Public Health", which was accepted for publication in the C.D.A. Journal in May 1961.

T A B L E I

VALUES FOR CORRELATION BETWEEN PROFILE ANGLE AND A-B DIFFERENCE IN BOYS AND GIRLS

B O Y S				G I R L S			
Age (Yrs)	r Value	Significance		Age (Yrs)	r Value	Significance	
		5% Level	1% Level			5% Level	1% Level
6	+ 0.4310	Yes (0.16)	Yes (0.21)	6	+ 0.464	Yes (0.17)	Yes (0.23)
8	+ 0.4609	Yes (0.19)	Yes (0.25)	8	+ 0.259	Yes (0.17)	Yes (0.23)
10	+ 0.422	Yes (0.19)	Yes (0.25)	10	+ 0.330	Yes (0.19)	Yes (0.25)
12	+ 0.507	Yes (0.19)	Yes (0.25)	12	+ 0.488	Yes (0.20)	Yes (0.27)

RESULTS OF CHI-SQUARE TESTS FOR POSSIBLE ASSOCIATION BETWEEN A-B RELATION AND CROWDING/NO CROWDING

FEMALES				MALES		
LIMITS OF A-B	AGE (YRS)	RESULTS		LIMITS OF A-B	AGE (YRS)	RESULTS
+ 2.0 mm. or less + 2.5 mm. or more	8	No Significant Association $P > 0.10$		+ 2.0 mm. or less + 2.5 mm. or more	8	No Significant Association $P > 0.70$
+ 2.5 mm. or less + 3.0 mm. or more	10	Significant Association $P < 0.05$		+ 2.0 mm. or less + 2.5 mm. or more	10	Significant Association $P < 0.01$
+ 0.5 mm. or less + 1.0 mm. or more	12	No Significant Association $P > 0.30$		+ 1.0 mm. or less + 1.5 mm. or more	12	No Significant Association $P > 0.30$

RESULTS OF CHI-SQUARE TESTS FOR POSSIBLE ASSOCIATION BETWEEN A-B RELATION AND NEUTROCCLUSION/DISTOCCLUSION

FEMALES				MALES		
LIMITS OF A-B	AGE (YRS)	RESULTS		LIMITS OF A-B	AGE (YRS)	RESULTS
+ 2.0 mm. or less + 2.5 mm. or more	8	Significant Association $P < 0.02$		+ 2.0 mm. or less + 2.5 mm. or more	8	Significant Association $P < 0.01$
+ 2.5 mm. or less + 3.0 mm. or more	10	No Significant Association $P > 0.08$		+ 2.0 mm. or less + 2.5 mm. or more	10	Significant Association $P < 0.01$
+ 0.5 mm. or less + 1.0 mm. or more	12	Significant Association $P < 0.01$		+ 1.0 mm. or less + 1.5 mm. or more	12	Significant Association $P < 0.05$

T A B L E III

RESULTS OF CHI-SQUARE TESTS FOR POSSIBLE ASSOCIATION BETWEEN PROFILE ANGLE AND CROWDING/NO CROWDING

FEMALES			MALES		
LIMITS OF P/A	AGE (YRS)	RESULTS	LIMITS OF P/A	AGE (YRS)	RESULTS
171.0° or less 171.5° or more	8	No Significant Association $P \geq 0.50$	172.5° or less 173.0° or more	8	No Significant Assoc. $P \geq 0.50$
173.0° or less 173.5° or more	10	No Significant Association $P \geq 0.70$	173.0° or less 173.5° or more	10	No Significant Assoc. $P \geq 0.70$
174.0 or less 174.5 or more	12	No Significant Association $P \geq 0.50$	174.0 or less 174.5 or more	12	Significant Association $P < 0.05$

RESULTS OF CHI-SQUARE TESTS FOR POSSIBLE ASSOCIATION BETWEEN PROFILE ANGLE AND NEUTROCLUSION/DISTOCCLUSION

FEMALES			MALES		
LIMITS OF P/A	AGE (YRS)	RESULTS	LIMITS OF P/A		RESULTS
171.0° or less 171.5° or more	8	Significant Association $P < 0.05$	172.5° or less 173.0° or more	8	Significant Association $P < 0.02$
173.0 or less 173.5 or more	10	No Significant Association $P \geq 0.50$	173.0° or less 173.5° or more	10	No Significant Assoc. $P \geq 0.30$
174.0° or less 174.5° or more	12	Significant Association $P < 0.02$	174.0° or less 174.5° or more	12	No Significant Assoc. $P \geq 0.10$

General Information			Detailed Information			Summary		
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APPENDIX

Age Group: 8 yrs Sex: M N: 25 Type of Radiogram: Laterals

Case Number	DENTAL CHARACTERISTICS						CRANIO-FACIAL CHARACTERISTICS			
	Dentition	N D M	Overjet	Crowding	Incisor Inclin- ation	A - B Relation	Deep Bite	Jaw Relation to ANS	Facial Angle	Cranio Occlusal Angle
673	N		N	N		+3	N		172	37
199	N		N	N		+3	N		176	38
885	N		N	N		+3.5	N		180	37.5
459	N		N	+		+0.5	+		169.5	41
646	N		N	N		+2	N		174.5	40
572	N		N	N		+1	N		180	35
1182	N		N	+		+1.5	N		175.5	39.5
429	N		N	N		+4	N		180.	36.5
546	D		+	N		+1.	+		170	38
943	N		N	N		+4.5	N		176.5	35
583	N		N	N		+2	N		180	38
705	N		N	+		+4.5	N		177.5	41.5
299	N		N	N		+1.	N		173.5	41.
1076	N		N	N		+1	N		171.	36
1044	N		N	N		+7.5	N		188.5	39.5
1145	N		N	-		+4.0	N		175	38.
534	N		N	N		+5.0	N		175	42.
190	N		N	N		+4.0	N		175	35
898	D		+	-		-3.0	+		171	31.5
286	N		+	-		+1.	-		164	44
697	D		+	-		-1.	+		164.5	36.5
946	N		+	-		+2.5	+		175	38.
1124	N		N	N		+6.5	N		180	37.
1210	N		N	N		+3.5	N		170.5	41.
420	N		+	-		+3.0	+		171.5	39.

Age Group: 8 yrs Sex: M N: 25 Type of Radiogram: Laterals

Case Number	DENTAL CHARACTERISTICS					CRANIO-FACIAL CHARACTERISTICS			
	Dentition D M	Overjet	Crowding	Incisor Inclin- ation	A - B Relation	Deep Bite	Jaw Relation to ANS	Facial Angle	Cranio Occlusal Angle
415	D	+	N		-5.5	+2		164.5	34.
1026	N	N	N		+3.0	N		172.	37
1175	N	-	N		+1.5	N		173.5	41
1165	N	N	N		+1.0	N		173.	34
553	N	N	N		0	N		168.	36.
569	N	N	N		+4.	N		178	40
451	N	N	N		+3.	N		169.5	40
667	N	N	N		+3	N		175.	44
1119	D	+	N		+2.5	+		180	36
774	N	N	N		-1.0	N		165	37
1067	N	N	N		+3.0	N		182	35.5
811	N	N	N		-0.5	N		170	37.5
500	N	N	N		+2.5	N		172	38.5
832	D	+	N		0	+		168.5	42.5
247	D	+	N		-0.5	+		168	37.
433	N	N	N		+4.0	N		160.5	44.5
809	N	N	N		+4.0	N		167.	38.5
663	D	+	N		+2.0	+		180	39.0
842	D	+	N		-0.5	N		168.5	36.5
986	N	+	N		+3.5	+		176.	41.
907	N	N	N		+4.5	N		168	40
463	N	N	N		+4.5	N		171	41.5
730	N	N	N		+4.5	N		177	36.
1063	N	+	-		+8.0	N		177.5	38.
542	N	N	+		+5.5	N		171.5	42.

Age Group: 8 yrs. Sex: M N: 26 Type of Radiogram: Laterals

Case Number	DENTAL CHARACTERISTICS						CRANIO-FACIAL CHARACTERISTICS		
	Dentition	Overjet	Crowding	Incisor Inclination	A - B Relation	Deep Bite	Jaw Relation to ANS	Facial Angle	Cranio Occlusal Angle
835	N	N	+		+2.	N		169.5	42.5
434	N	N	N		+2.	N		171.	37.0
437	D	+	N		+1.	+		165.5	38.
558	D	+	N		-3.	+		160	48
1108	N	N	N		+1.	N		171	40.5
1105	N	N	N		+3.	N		173	39.0
957	N	N	N		-8.	N		165	32.5
1132	N	N	N		-3.	N		176	34.
335	D	+	+		-1.	+		180	37.
808	N	N	N		+3.5	N		175.5	39.
826	D	N	+		-5.	+		164.5	38.
584	N	N	N		-3.	N		172.	33.
960	N	N	N		+4.	N		184	37.
1032	N	+	-		+0.5	+		170	39
903	D	N	+		+0.5	N		168	37
464	N	N	N		+0.5	N		173	36.5
642	N	N	N		+2.	N		178	38
708	N	N	+		+2.	N		177	39
1066	D	+	N		-4.	+		172.5	36.5
1120	N	N	+		+1.5	+		162.5	43.5
803	D	+	N		-3.	+		161.	36.5
567	N	+	+		+5	N		180	39.5
900	N	N	N		+3.	N		177.5	38.5
905	D	+	+		+3.	+		174	41.5
514	D	+	+		+3.	+		171	39.5
327	D	+	N		-2.	+		162.5	38.5

Age Group: 8 yrs. Sex: M N: 21 Type of Radiogram: Laterals

Case Number	DENTAL CHARACTERISTICS						CRANIO-FACIAL CHARACTERISTICS		
	Dentition D M	Overjet	Crowding	Incisor Inclin- ation	A - B Relation	Deep Bite	Jaw Relation (Po to ANS)	Facial Angle	Cranio Occlusal Angle
812	N	N	N		+3.5	N		172.	44.5
431	N	+	-		+3.	+		166	43.5
844	N	N	N		+6.	N		169.5	46.0
1041	D	+	N		+2.	+		169.5	41.
587	N	N	N		+4.	N		171.	43.
427	D	+	+		-2.5	+		170.5	37.5
783	D	+	N		-2.	+		173.5	41.
1081	D	+	N		-2.	+		169.5	32.5
593	N	N	N		+5.	N		176.	38.
951	N	N	N		+3.5	N		170	45.5
394	D	+	+		+5.5	N		180	41
949	D	+	N		-1.5	+		166.5	37.
732	N	N	N		+1.5	N		166	42.5
419	N	-	N		+6.0	N		176	38.
413	N	N	N		+1.5	N		173	40.5
414	N	N	N		+4.0	N		173	42.5
1035	N	N	+		+6.0	N		176	40.5
925	N	N	N		-2.0	N		165	43.0
1037	N	N	N		+3.	N		165	41.5
1170	D	+	N		-2	+		176	36.
1191	N	N	N		+1	N		168.5	37.

Serial Treated

of

Age Group: 6 & 8 yrs Sex: M

N: 26

Type of Radiogram: Lateral

7 pages

Case Number	DENTAL CHARACTERISTICS						CRANIO-FACIAL CHARACTERISTICS						
	Dentition		Overjet	Crowding	Incisor Inclination	A - B Relation	Overbite	Jaw Relation to ANS	Facial Angle	Cranio Occlusal Angle			
	N	D											
	6	8	6	8		6	8	6	8	6	8		
278	N	N	N	N		-1	+4	N	N	166.5	170.5	37.	41.
133	N	D	N	N		+1	+1.5	N	N	172.5	175.	35.5	38.5
319	N	N	N	N		-2.5	-0.5	N	+	167.	168.5	28.5	31.5
387	N	N	N	N		-2.5	-2	N	N	163.	164.5	35.5	38.5
244	N	N	N	N		-0.5	+2.5	N	N	165.	168.5	36.5	40.5
266	D	N	N	N		-5.5	-1.	N	N	162.5	169.5	37.	37.5
375	N	D	N	N		+0.5	+4.5	N	+	174	178.5	35.	35.
152	N	N	N	N		-1.5	-3.	N	+	176.	177.5	32.	30.
144	N	D	N	N		+1.5	+4.5	N	N	172	173.5	34.	41.
641	N	D	N	N		+0.5	+1.5	N	N	167.5	168.5	36.5	42.5
889	N	N	N	N		+3.	+2.	N	N	168.5	169.	35.5	37.5
706	D	N	N	N		-4.5	-2.	N	N	171.	172.5	30.	31.5
483	N	N	N	N		+2.	+3.5	N	N	168.5	171.5	42.	39.5
723	N	D	N	N		-0.5	+1	N	+	167.	168.	32.5	35.5
131	N	N	N	N		0	-0.5	N	N	167.	170.5	34.	32.5
135	N	N	N	N		0	+2.	N	N	169.5	173.	35.5	35.5
392	N	N	N	N		-1	+1.5	N	N	172.	174.	33.5	34.5
498	N	D	N	N		-5	-2.5	N	+	161.5	165.	34.	36.5
636	N	N	N	N		+3.5	+5.5	N	N	175.5	177.5	41.5	40.5
478	D	N	N	N		+0.5	-1.5	N	N	167.	169.5	37.	31.
191	N	D	N	N		+2.	-0.5	N	N	169.	165.5	33.5	35.5
121	N	D	N	N		-1.	+1.5	N	+	167.	168.	35.5	37.
169	N	N	N	N		-1.5	-0.5	N	N	167.5	168.5	34.5	36.5
470	N	N	N	N		+2.5	+1.	N	+	167.5	168.5	43.5	41.
186	D	D	N	N		0.	-2.5	N	+	164.	166.	35.	35.
492	N	D	N	N		-2.5	-2.5	N	+	164.	166.	38.	38.

Serial Treated

of

Age Group: 6 & 8 yrs

Sex: M

N: 23

Type of Radiogram: Lateral

7 pages

Case Number	DENTAL CHARACTERISTICS										CRANIO-FACIAL CHARACTERISTICS									
	Dentition		Overjet		Crowding		Incisor Inclination		A - B Relation		Overbite		Jaw Relation to ANS		Facial Angle		Cranio Occlusal Angle			
	6	8	6	8	6	8	6	8	6	8	6	8	6	8	6	8	6	8		
761	D	D	+	+	N	-	-0.5	+4.	-	N	N	N			163.5	162.	39.	45.		
859	N	N	N	N	N	N	-2.	-1.	N	N	N	N			168.	167.5	32.5	32.5		
488	D	D	+	+	N	N	-5.5	-5.	N	N	+	N			168.	169.	41.	40.5		
294	N	N	N	N	N	N	0	0	N	N	N	N			172.	180.	34.	35.		
763	N	N	N	N	N	N	-2.	-1.5	N	N	N	N			164.	168.	33.	36.		
871	N	N	N	N	N	N	-0.5	+3.	N	N	N	N			169.	174.	32.	34.		
604	N	N	N	N	N	N	+1.	+1.	N	N	N	N			170.5	172.	36.5	33.5		
106	N	N	N	N	N	N	+1.	+4.	N	N	N	N			176.5	181.5	35.	40.5		
624	N	N	N	N	N	N	-1.	-2.5	N	N	N	N			165.5	166.	38.5	37.		
721	N	N	N	N	N	N	-3.5	+1.	N	N	N	N			167.	170.5	35.5	41.5		
622	N	N	N	N	N	N	-2.	+3.5	N	N	N	N			168.	170.	34.	40.		
189	N	N	N	N	N	N	+5.5	+1.	N	N	N	N			165.5	168.	49.	42.5		
719	N	N	N	N	N	N	-1.	+0.5	N	N	N	N			166.	167.	34.5	37.5		
621	N	N	N	N	N	N	-0.5	+2.5	N	N	N	N			163.	163.5	38.	43.5		
213	N	N	N	N	N	N	+0.5	+1.5	N	N	N	N			170.5	172.5	41.	39.5		
320	D	D	+	+	N	N	0	-1.5	N	N	N	N			167.5	161.5	36.	38.5		
490	N	N	N	N	N	N	+0.5	+3.	N	N	N	N			175.5	174.5	25.5	37.5		
351	N	N	N	N	N	N	-3.5	-4.5	N	N	N	N			163.	165.	35.5	31.5		
495	N	N	N	N	N	N	+1.	0	N	N	N	N			171.	171.	36.5	35.		
491	N	N	N	N	N	N	+0.5	-3.	N	N	N	N			164.5	164.5	33.	33.		
544	N	N	N	N	N	N	-2.	+1.5	N	N	N	N			170.5	170.5	34.	35.5		
598	N	N	N	N	N	N	+1.5	+2.5	N	N	N	N			175.	179.5	34.5	37.		
597	N	N	N	N	N	N	-0.5	-1.	N	N	N	N			170.5	172.5	39.	35.5		

Serial Treated

of

Age Group: 6 & 8 yrs

Sex: M

N: 3 Type of Radiogram: Lateral

7 pages

Case Number	DENTAL CHARACTERISTICS							CRANIO-FACIAL CHARACTERISTICS					
	Dentition		Overjet	Crowding	Incisor Inclination	A - B Relation	Overbite	Jaw Relation	Po to ANS	Facial Angle	Cranio Occlusal Angle		
	N	D											
	6	8	6	6	8	6	8	6	6	8	6	8	
352	D	D	+	N	-	-2.	+				164.	35.	34.
1297	N	N	N	N	N	+1.5	N				171.5	39.	38.5
1298	N	N	N	N	N	+1.	N				174.	38.5	40.5

Age Group: 8 yrs. Sex: F N: 26 Type of Radiogram: Laterals

Case Number	DENTAL CHARACTERISTICS					CRANIO-FACIAL CHARACTERISTICS			
	Dentition	Overjet	Crowding	Incisor Inclination	A - B Relation	Deep Bite	Jaw Relation to ANS	Facial Angle	Cranio Occlusal Angle
990	D	N	N		+4.0	N		170.5	45.
816	N	N	N		+2.5	N		176.5	37.5
246	N	N	N		+5.0	N		174.5	37.5
1064	N	N	+		+1.0	N		172.5	37.0
393	N	N	N		+3.5	N		176.5	32.
234	N	N	+		+2.0	N		174.	40.5
794	N	N	N		0	N		170	38.
430	N	N	N		+1	N		167.	41
441	N	N	N		0	N		171	35.5
148	D	+	N		-1.0	+		165	39.
707	N	N	N		+2.0	N		180	32.
591	N	N	N		+2.0	N		172.5	38
127	N	N	-		-0.5	N		172.5	34
1065	N	N	N		+5.5	N		177.5	44.5
820	N	N	+		+7.0	N		179.	35.5
240	N	N	N		+4.0	N		177	36.0
333	D	+	-		-0.5	+		176	35.5
503	D	+	+		+0.5	+		180	32.0
666	N	+	+		+2.0	N		177	36.5
474	D	+	N		+0.5	+		168.5	42.
522	N	N	N		+2	N			
921	N	N	N		+4.0	N		177.5	41
976	N	N	N		-0.5	N		167.	39
840	D	+	N		+1.0	+		161	40.5
384	D	+	+		+1.5	N		161	47
1098	M	-	N		+5.0	N		169	41.5

Case Number	DENTAL CHARACTERISTICS					CRANIO-FACIAL CHARACTERISTICS			
	Dentition D M	Overjet	Crowding	Incisor Inclin- ation	A - B Relation	Deep Bite	Jaw Relation to ANS	Facial Angle	Cranio Occlusal Angle
129	N	N	N		0	N		168.5	40
853	N	N	N		+4.0	N		167.0	40
1027	D	+	N		+2.0	+		176.5	39
679	N	N	N		+4.0	N		170	37
526	N	N	N		-0.5	N		169	36
1305	N	N	N		+1.0	N		174.5	39
1304	N	N	+		+1.0	+		174.5	37
447	N	N	N		+1.5	N		174	39.5
795	N	N	-		-1.0	-		166.5	36.5
380	D	+	N		+5.0	+		162	42.0
1087	D	N	+			N		173	43.5
911	N	N	N			N			
746	D	+	N		-1.0	+		176.5	35.5
525	N	+	N		-1.0	N		170.5	37.5
1138	D	+	-		+0.5	+		174.	41
915	N	N	N		+2.5	N		172	35
424	N	+	N		+3.0	N		171	33.5
703	D	+	N		-1.5	+		171	36.
677	D	+	+		-4.0	N		171	36
810	D	+	N		0	+		171.5	39.5
685	N	+	N		+4.0	N		174.5	32.5
178	D	+	N		-2.0	+		166	43.5
523	D	N	+		-1.0	N		165	39.
787	N	N	N		+0.5	N		170	38.5
847	N	N	N		-1.0	N		166.5	39.
848	N	N	N		+0.5	N		166.5	39

Age Group: 8 yrs.

Sex: F

N: 25

Type of Radiogram: Laterals

5 pages

Case Number	DENTAL CHARACTERISTICS						CRANIO-FACIAL CHARACTERISTICS			
	Dentition	N	Overjet	Crowding	Incisor Inclination	A - B Relation	Deep Bite	Jaw Relation to ANS	Facial Angle	Cranio Occlusal Angle
655	N		+	+		+1.5	+		164	44
383	N		N	N		-1.0	N		166.5	36.5
937	D		+	-		-0.5	+		162.5	34.5
446	N		+	-		+4.0	-		173.5	38.0
1171	N		+	N		+7.0	+		168	44.5
425	N		N	N		-1.0	N		175	33.0
881	N		N	N		+1.5	N		170	42
652	N		N	N		-1.0	N		171	41.5
31	N		N	+		+7.0	N		164	46.
512	N		N	N		+2.0	N		174.5	40
799	N		N	N		+4.0	N		173	35
128	N		N	N		+4.0	N		168	32
698	D		+	N		+2.5	+		170.5	42
970	N		+	N		+1.5	+		159.5	46
947	N		N	N		+4.0	N		180	37
560	N		N	N		+4.0	N		173	37
992	N		+	+		+6.0	+		171.5	48.5
747	N		+	+		+1.0	+		166.5	36
939	N		N	N		0	N		168.5	38
1156	N		N	+		+2.0	N		169.5	45
1127	N		N	N		+3.0	N		170	40
1111	D		+	+		-1.0	N		170.5	37
292	D		+	+		-0.5	+		167	43
712	N		N	N		+4.0	N		172	41
781	D		N	+		-2.0	N		162	38.5
438	N		N	N		+5.5	N		177	41

Age Group: 8 yrs.

Sex: F

N: 26

Type of Radiogram: Laterals

Case Number	DENTAL CHARACTERISTICS					CRANIO-FACIAL CHARACTERISTICS				
	Dentition	N D M	Overjet	Crowding	Incisor Inclination	A - B Relation	Deep Bite	Jaw Relation to ANS	Facial Angle	Cranio Occlusal Angle
981	D		+	+		+1.5	+		170	42
428	N		N	+		+0.5	-		165	39.5
704	N		N	N		+2.0	N		172	37.
656	D		+	N		+2.0	+		170	36.5
1073	N		+	+		+1.0	+		174.5	40.5
680	N		N	+		+3.5	N		171.	43.
422	D		+	+		+1.5	+		178	39.5
388	N		+	-		+1.0	+		168	39
733	N		N	N		0	N		167.5	37
192	D		+	N		-1.0	N		170	37.5
700	N		N	N		+3.0	N		168	42
1169	D		N	+		-1.5	+		161	38
845	N		+	+		+1.0	+		167.5	41
1042	D		N	+		+1.0	N		169.5	42
439	N		N	N		+2.0	N		180.	38.5
770	D		+	N		+2.0	N		178	38
123	D		N	N		+4.0	N		172	39.5
702	D		+	+		-1.0	+		166	42.5
1146	N		N	N		+4.5	N		174	36
1123	N		N	N		+4.0	N		180	39.5
1075	N		N	N		+4.0	N		167.5	42.0
728	N		N	N		+1.0	N		173	36.0
841	N		+	+		+2.0	+		172	40
1040	N		+	+		+3.0	+		170	38.5
536	N		N	N		+1.0	N		169	33.5
932	N		N	N		+7.0	N		176.5	35.5

Cross Sectional Controls

BURLINGTON ORTHODONTIC RESEARCH: Analysis of Cranio-Facial Characteristics

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of
5 pages

Age Group: 8 yrs			Sex: F	N: 20	Type of Radiogram: Laterals		5 pages		
Case Number	DENTAL CHARACTERISTICS					CRANIO-FACIAL CHARACTERISTICS			
	Dentition D M	Overjet	Crowding	Incisor Inclin- ation	A - B Relation	Deep Bite	Jaw Relation to ANS	Facial Angle	Cranio Occlusal Angle
513	N	+	+		+1.0	+		166	39.5
193	D	+	N		+2.0	+		172	41.
935	D	+	N		+5.0	+		183.5	42.5
984	N	N	N		+2.0	N		175	36.5
762	N	+	+		+0.5	+		172	42
589	D	+	+		+4.0	+		163	39
588	D	+	+		-7.0	+		162.5	33
550	N	N	N		+2.0	N		170	37.5
549	N	N	N		-1.0	N		168	36.5
1176	N	N	N		-1.0	N		168	33.
693	N	N	N		+1.0	N		172	39
237	N	N	N		+4.0	N		172	45.5
559	N	N	N		+3.0	N		174	37.5
440	D	+	N		+2.0	N		170	42.
924	N	N	N		+4.5	+		166	45
778	N	N	N		-1.0	+		166	40.5
910	N	N	N		-1.0	+		168	33.5
725	D	-	+		+3.0	+		171	41.5
754	N	N	N		+4.5	N			36.
1029	N	N	N			N			

Case Number	DENTAL CHARACTERISTICS										CRANIO-FACIAL CHARACTERISTICS						
	Dentition		N M	Overjet		Crowding		Incisor Inclination	A - B Relation		Overbite	Jaw Relation	Po to ANS	Facial Angle		Cranio Occlusal Angle	
	6	8		6	8	6	8		6	8				6	8		
334	N	N		N	N		N		+3.	+5.	N			174.	174.	35.5	39.
107	N	N		N	N		N		+0.5	+4.	N			171.	170.5	36.	43.
245	D	D		N	N		N		-1.5	+1.	N			158.	164.	41.5	44.5
137	N	N		N	N		N		-1.	+4.5	-			162.	168.5	40.5	48.
545	M	N		N	N		N		+7.5	+11.	N			174.	180.	39.5	41.5
736	N	N		N	N		N		+1.	+4.	N			170.	174.	36.	38.
368	N	N		N	N		N		+1.	+4.5	N			170.5	170.5	34.	39.
465	N	N		N	N		N		-0.5	+0.5	N			176.5	177.5	32.5	34.5
252	N	N		N	N		N		+3.5	+7.	N			173.	173.5	40.5	44.5
198	N	N		N	N		N		+1.5	+6.	N			172.	175.	35.	42.5
313	N	N		N	N		N		+5.	+4.	N			170.	167.5	37.	42.
606	N	N		N	N		N		+2.	+3.	N			174.	176.5	40.	40.
861	N	N		N	N		N		+1.	+3.5	N			168.5	173.5	34.5	35.5
640	N	N		N	N		N		+1.	+2.	N			165.	171.5	37.5	39.
188	N	N		N	N		N		-3.5	-0.5	N			163.	167.	33.	33.
716	D	N		N	N		N		-2.	-1.	N			172.5	173.5	36.	34.
304	N	D		N	N		N		+1.	-0.5	N			170.5	170.5	36.	33.
257	N	D		N	N		N		-0.5	-2.	N			162.	163.5	35.5	34.
595	N	N		N	N		N		-0.5	-1.	N			165.	165.	35.5	37.
287	D	N		N	N		N		-0.5	+5.	N			168.5	175.	35.5	40.
274	N	N		N	N		N		-1.	+1.	N			170.	171.	39.	37.
272	D	N		N	N		N		-1.5	-2.	N			169.	174.	35.5	42.
657	N	N		N	N		N		+3.	+6.5	N			169.5	175.5	42.5	41.5
619	N	N		N	N		N		-1.5	+0.5	N			169.5	172.5	32.5	34.
590	D	N		N	N		N		+1.	-2.5	N			164.	165.	42.5	38.5
893	N	N		N	N		N		-3.	-2.	N			159.5	160.	35.	36.
162	N	N		N	N		N		0	+0.5	N			165.5	169.5	38.5	39.
602	N	N		N	N		N		+2.5	+3.5	N			171.5	175.	43.	44.
25	N	N		N	N		N		+0.5	+0.5	N			164.5	169.5	42.5	38.

Case Number	DENTAL CHARACTERISTICS						CRANIO-FACIAL CHARACTERISTICS			
	Dentition	N	Overjet	Crowding	Inclination	A - B Relation	Overbite	Jaw Relation to ANS	Facial Angle	Cranio Occlusal Angle
	6	8	6	8		6	8		6	8
890	N	N	N	N		+2.5	N		173.	174.
138	N	N	N	N		+1.	N		171.5	176.5
74	N	N	N	N		-4.	N		162.5	166.
317	N	N	N	N		+2.	N		170.	173.5
229	N	N	N	N		-1.5	N		164.	165.
874	N	N	N	N		-1.	N		167.5	169.5
625	N	N	N	N		+2.	N		173.	174.5
532	N	N	N	N		+3.5	N		180.5	180.
210	N	N	N	N		+1.	N		171.	172.5
132	N	N	N	N		+0.5	N		168.5	169.5
220	N	N	N	N		-3.	N		165.5	173.
469	N	N	N	N		+1.	N		180.	181.
208	N	N	N	N		-3.5	N		166.	170.
613	N	N	N	N		+1.	N		173.	176.5
211	D	D	N	N		-3.5	N		173.5	172.5
487	N	N	N	N		-1.	N		165.5	171.
155	N	N	N	N		+4.5	N		167.5	167.5
617	D	D	N	N		-1.	N		167.	166.
486	N	N	N	N		+4.5	N		168.	173.
204	N	N	N	N		+4.	N		168.5	169.5
502	N	N	N	N		+0.5	N		171.	174.
1271	N	N	N	N		-1.	N		174.	174.5
230	N	N	N	N		+1.	N		172.5	174.5
472	N	N	N	N		0	N		167.	168.5
44	N	N	N	N		-6.	N		170.	171.
713	N	N	N	N		+2.	N		175.	174.
316	N	N	N	N		+2.	N		170.5	169.

Case Number	DENTAL CHARACTERISTICS					CRANIO-FACIAL CHARACTERISTICS				
	Dentition	N	Overjet	Crowding	Incisor Inclination	A - B Relation	Deep Bite	Jaw Relation to ANS	Facial Angle	Cranio Occlusal Angle
1149	N		+	+		+3.0	++		171.	45.0
993	N		N	N		+2.5	N		172.5	41.5
817	N		N	N		+4.0	N		175.	40.5
1225	N		N	N		+2.0	+		170	38.5
1278	N		++	N		+3.0	++		171	33.0
777	D		N	N		0	N		173.5	35.5
1047	N		N	N		+4.5	N		175.5	38.0
201	N		N	N		+1.5	N		172.5	38.0
962	N		N	N		+8.0	N		181.5	39.5
836	N		N	N		+2.5	N		171.5	41.0
1083	N		N	N		+0.5	N		169.5	37.5
987	N		N	N		+5.0	N		172.	45.0
1269	N		N	N		+1.0	N		166	39.0
852	N		N	N		+1.0	N		173	34.5
1193	N		N	N		+2.5	N		169.5	41.0
958	D		++	N		+2.5	++		174	39.0
386	N		N	N		+1.0	N		169	35.5
1243	N		N	N		+5.0	N		180	39.5
561	N		N	N		+3.0	+		170.5	43.0
367	N		N	N		+2.0	-		165	43.0
326	N		N	N		+2.5	N		170.5	44.0
23	N		N	N		+2.0	N		171	42.0
233	N		N	N		+3.0	N		175	37.5
784	N		N	N		+3.0	-		170	40.5
1265	N		+	N		0	+		165.5	39.0
573	N		+	N		+4.0	N		178	38.5

BURLINGTON ORTHODONTIC RESEARCH: Analysis of Cranio-Facial Characteristics

Age Group: 10 yrs Sex: F N: 26 Type of Radiogram: Laterals

Case Number	DENTAL CHARACTERISTICS					CRANIO-FACIAL CHARACTERISTICS		
	Dentition	Overjet	Crowding	Incisor Inclination	A - B Relation	Deep Bite	Jaw Relation to ANS	Cranio Occlusal Angle
1190	N	N	N		+2.0	N	176	40
1069	N	N	N		0	N	170.5	36
1103	D	N	+		+1.0	N	182.5	33.5
1118	N	N	N		+3.5	N	165	42.5
901	N	N	N		+1.0	N	173.5	34.0
308	N	N	+		+2.5	N	171	37
888	N	N	N		+3.0	N	172	36.5
1244	N	N	+		0	N	177	40.5
1001	N	++	+		+5.0	+	176.5	41
908	N	+	+		-0.5	+	166.5	35
1078	N	N	N		+6.5	N	177.5	38.5
1206	N	N	N		+3.0	N	178	36
473	N	N	N		+3.5	N	175	35.5
458	N	N	N		+7.0	+	183	38.5
1095	N	+	N		+4.0	N	164	41
686	N	N	N		+7.0	N	175.5	42.5
1237	N	N	N		+1.5	-	165	39
301	N	N	N		+6.0	N	171.5	41
445	N	++	+		-2.0	++	162	40
1151	D	+	+		+0.5	+	170.5	39
448	N	N	+		-3.0	+	171	36.5
779	N	N	N		+3.5	-	169.5	39
307	N	N	N		-1.0	N	171	35.5
518	D	++	++		+3.0	N	178.5	35
760	N	N	N		+3.0	N	177.5	36
1181	D	+	N		+5.5	+	176	43

BURLINGTON ORTHODONTIC RESEARCH: Analysis of Cranio-Facial Characteristics
Age Group: 10 yrs. Sex: F N: 26 Type of Radiogram: Laterals

Case Number	DENTAL CHARACTERISTICS					CRANIO-FACIAL CHARACTERISTICS		
	Dentition	N	Overjet	Crowding	Incisor Inclination	A - B Relation	Deep Bite	Jaw Relation to ANS
347	D		+	+		+4.0	++	164
791	N		N	N		+2.0	N	168.5
1096	N		N	N		+8.5	N	172.5
768	D		++	N		+3.0	+	165.5
813	N		N	+		+4.0	N	175
681	N		N	N		+1.0	N	177
1270	N		N	N		+7.5	N	179
1062	N		N	N		0	N	172.5
1104	N		+	+		+2.5	+	171.5
1246	N		N	N		+2.0	N	172
1053	N		N	N		+4.5	N	170
1121	D		N	+		+1.0	+	173.5
417	N		N	N		0	N	167
1251	N		N	N		+3.0	N	175
983	N		N	N		+3.0	N	167.5
963	N		N	+		+1.0	N	173
1049	N		N	N		+6.0	N	173.5
843	N		N	N		+2.5	N	173
968	N		N	+		+3.5	N	183.5
931	N		N	+		-1.0	N	167
643	N		N	N		+2.5	N	175
1241	N		N	N		+3.5	N	170
883	N		N	N		+3.0	N	177
678	N		N	N		-1.5	N	164.5
356	N		N	+		+0.5	+	174
435	N		N	N			N	

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5 pages

Age Group: 10 yrs.

Sex: F

N: 26

Type of Radiogram: Laterals

Case Number	DENTAL CHARACTERISTICS					CRANIO-FACIAL CHARACTERISTICS			
	Dentition D M	Overjet	Crowding	Incisor Inclination	A - B Relation	Deep Bite	Jaw Relation to ANS	Facial Angle	Cranio Occlusal Angle
991	N	N	N		+2.0	N		175	40
568	N	N	N		-	N		-	-
11	N	N	N		+3.5	N		164.5	43.5
769	N	N	N		-2.0	N		171	40
517	N	N	N		-	N		-	-
1012	N	N	N		+2.0	N		177	34.5
1158	N	N	N		+1.0	N		182.5	31.5
1197	D	++	N		+2.5	=		154.5	48
710	N	N	N		+1.0	N		174	35
1250	N	N	N		+2.5	N		174	34.5
1116	N	N	N		+8.5	N		177	42
1137	N	N	N		+2.5	N		176	39.5
955	N	N	N		+2.5	N		174.5	41.5
552	N	N	N		+1.5	N		173	35
547	N	N	N		+3.0	N		171	39.5
374	N	N	N		+2.0	N		180	37.5
310	N	N	N		+2.5	N		169.5	39.5
149	N	N	N		+0.5	N		171	40
284	D	N	N		-1.0	N		171	39
1263	N	N	N		+5.0	N		172	43.5
748	N	N	N		-1.0	N		170	40.5
389	N	N	N		+3.5	N		180	37
1159	N	N	N		+5.0	N		177.5	39.5
731	D	N	N		+2.0	N		176	35
594	D	N	N		-3.0	++		175	36.5
1117	N	N	N		+5.0	N		187.5	35

BURLINGTON ORTHODONTIC RESEARCH: Analysis of Cranio-Facial Characteristics
Age Group: 10 yrs. Sex: F N: 4 Type of Radiogram:

Case Number	DENTAL CHARACTERISTICS					CRANIO-FACIAL CHARACTERISTICS			
	N Dentition D M	Overjet	Crowding	Incisor Inclin- ation	A - B Relation	Deep Bite	Jaw Relation to ANS	Facial Angle	Cranio Occlusal Angle
260	N	N	N		+6.0	N		178	?
331	N	+	N (-)		+2.0	N		165	?
709	N	N	N		+0.5	N		175	?
1261	N	N	N		+3.0	N		176.5	?

BURLINGTON ORTHODONTIC RESEARCH: Analysis of Cranio-Facial Characteristics					Page 1 of 5 pages				
Age Group: 10 yrs		Sex: M	N: 26	Type of Radiogram: Laterals					
DENTAL CHARACTERISTICS					CRANIO-FACIAL CHARACTERISTICS				
Case Number	Dentition D M	Overjet	Crowding	Incisor Inclin- ation	A - B Relation	Deep Bite	Jaw Relation to ANS	Facial Angle	Cranio Occlusal Angle
253	N	N	+		+2.0	N		179	36.5
1233	N (D?)	N	N		+2.5	N		175	38.5
1174	N	N	N		+4.5	N		176	35.5
1011	N	N	N		+2.0	N		172	36
179	N	N	N		0	N		167	39
1282	N (D?)	+	N		+5	+		170.5	40
1148	N	N	N		+4	N		176.5	42
978	D	+	++		-0.5	++		173	38
758	N (D?)	N	+		-3.0	++		176	32
109	D	++	+		-2.0	++		165	43
1166	N	++	N		+4.5	++		169.5	43.5
1010	D	++	+		+2.0	++		166.5	39.5
1227	N	N	N		+2.5	N		168.5	43.5
659	N	N	N		+2.5	N		173.5	37.5
975	N	++	++		+3.5	N		169	42
354	N (D?)	N	+		0	+		174	38
1232	N	N	N		+12.5	+		180	40.5
996	N	N	N		+1.5	N		178	32
125	N	N	N		+4.0	N		180	38.5
1242	N (D?)	+	N		0	+		175	35
1220	D	++	+		-1.5	++		171.5	37.5
938	D	++	N		-0.5	++		?	?
9	N	+	+		+9.5	N		173.5	42.5
1273	N	N	N		+3.0	N		173.5	35.5
1252	N	N	N		+3.0	N		175	39
682	N (D?)	++	+		+1.5	++		165	40

BURLINGTON ORTHODONTIC RESEARCH: Analysis of Cranio-Facial Characteristics

Age Group: 10 yrs Sex: M N: 26 Type of Radiogram: Laterals

Case Number	DENTAL CHARACTERISTICS					CRANIO-FACIAL CHARACTERISTICS		
	Dentition D M	Overjet	Crowding	Incisor Inclin- ation	A - B Relation	Deep Bite	Jaw Relation to ANS	Cranio Occlusal Angle
974	N	N	N		+5.5	N		34
916	N	N	N		+3.0	N		168.5
1091	D	N	N		+0.5	+		176.5
785	N	N	N		+2.0	N		169.5
515	N	+	+		-0.5	++		-
1093	D	+	N		-3.5	+		164
1277	N	N	+		+5.0	N		178.5
1101	N	N	N		+1.0	N		175
476	N	++	N		-1.0	++		175
977	D	N	+		+0.5	+		178
450	N	+	N		+2.5	+		175
449	N	N	N		+4.0	N		175.5
668	N	N	N		+5.5	N		180
539	N	N	N		0	N		173.5
187	D	++	N		+10.5	N		173.5
235	N	N	+		+6.5	++		170.5
1058	N	N	+		-2.0	N		169
1077	N	N	+		+5.0	+		183
1249	N	++	+		+2.5	N		174.5
1153	N	N	+		+5.5	++		172.
410	D	++	N		+1.5	+		169.5
1099	N	N	N		+1.5	-		177.5
1141	N	+	-		+3.0	++		172
516	N	N	N		+4.0	N		176
1230	D	+	N		0	+		175
1113	D	+	+		-0.5	+		175

BURLINGTON ORTHODONTIC RESEARCH: Analysis of Cranio-Facial Characteristics

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Age Group: 10 yrs Sex: M N: 26 Type of Radiogram: Laterals

Case Number	DENTAL CHARACTERISTICS					CRANIO-FACIAL CHARACTERISTICS			
	Dentition	Overjet	Crowding	Incisor Inclination	A - B Relation	Deep Bite	Jaw Relation to ANS	Facial Angle	Cranio Occlusal Angle
1236	N	+	+		+1	+		171.5	39
1268	D	+	+		-3.0	+		173.5	35
967	D	+	N		-2.0	+		166.5	36
1090	D	+	+		+1.0	++		172.5	41.5
851	N	N	N		+5.0	N		172	40.5
396	N	N	N		+2.5	N		180	36
1086	N	N	N		+5.0	N		173	40
348	M	N	N		+7.5	N		180	36.5
227	N	N	N		+1.5	N		170.5	39.5
941	N	N	N		+1.5	N		175.5	35.5
886	N	N	N		+3.0	N		167.5	39
973	N	N	N		-0.5	N		170.5	36
749	N	N	N		+1.0	N		170.5	35.5
385	N	N	N		+2.5	N		174	41.5
533	N	N	N		+1.0	N		175.5	34
899	N	N	N		+1.5	N		172	38
1283	N	N	N		-2.0	N		171	40
1052	N	N	N		+4.0	N		173	44
1218	N	N	N		+1.5	N		167	39
524	D	+	N		+0.5	+		169	39.5
788	N	N	N		+2.5	N		176	35.5
328	N	N	N		+3.0	N		176	40
711	N	N	N		+3.0	N		170.5	41.5
1212	N	N	N		0	+		163	40.5
959	N	+	N		-1.0	N		166.5	38.5
302	N	N	N		+3.5	N		173	35.5

BURLINGTON ORTHODONTIC RESEARCH: Analysis of Cranio-Facial Characteristics

Type of Radiogram: Laterals

N: 26

Sex: M

Age Group: 10 yrs

Case Number	DENTAL CHARACTERISTICS					CRANIO-FACIAL CHARACTERISTICS		
	Dentition D M	Overjet	Crowding	Incisor Inclin- ation	A - B Relation	Deep Bite	Jaw Relation to ANS	Po Angle
418	N	N	N		-4.0	N		172.5
1082	N	N	N		+3.0	N		-
1239	N	N	N		+4.	N		169.5
1271	N	N	N		+3.	N		177.5
879	N	N	N		+4.	N		163
505	N	N	N		-1.	N		170
1106	N	N	N		+2.	N		180
1186	N	N	N		-0.5	N		180
297	N	N	N		-1	N		169
501	N	N	N		+0.5	N		179
887	N	N	N		-0.5	N		171.5
854	N	N	N		+5.5	N		182
1167	N	N	N		-2.0	N		162
1168	N	N	N		+1.0	N		166
644	N	N	N		+1.0	N		164
926	N	N	N		4.5	N		175
303	N	N	N		+2.5	N		168
300	N	N	N		3.5	N		171.5
683	N	N	N		+6.0	N		174.5
1003	N	N	N		+2.5	N		173.5
647	N	N	N		+5.0	N		172
358	N	N	N		0	N		167.5
566	N	N	N		+3	N		175.5
1258	N	N	N		+3.5	N		182
562	N	N	N		+1.5	N		172.5
1296	N	N	N		+5.0	N		175.5

BURLINGTON ORTHODONTIC RESEARCH: Analysis of Cranio-Facial Characteristics
Age Group: 10 yrs Sex: M N: 6 Type of Radiogram: Laterals

Case Number	DENTAL CHARACTERISTICS					CRANIO-FACIAL CHARACTERISTICS			
	Dentition D M	Overjet	Crowding	Incisor Inclination	A - B Relation	Deep Bite	Jaw Relation to ANS	Facial Angle	Cranio Occlusal Angle
687	N	N	N		+4.5	N		175.5	40.
453	N	N	N		0	N		168	35.5
1178	N	N	N		+5.5	N		175	37
1002	N	N	N (-)		?	N			
1259	N	+	N		+2.5	N		169	31.5
390	N	N	N		+3.0	N		171	43

BURLINGTON ORTHODONTIC RESEARCH: Analysis of Cranio-Facial Characteristics
 Age Group: 12 yrs Sex: M N: 26 Type of Radiogram: Laterals

Case Number	DENTAL CHARACTERISTICS					CRANIO-FACIAL CHARACTERISTICS			
	Dentition D M	Overjet	Crowding	Incisor Inclin- ation	A - B Relation	Deep Bite	Jaw Relation to ANS	Facial Angle	Cranio Occlusal Angle
989	D	+	N		+3.	+		165	40
344	D	+	+		+4.	+		179	39.5
972	N	N	N		+2.	N		177.5	34.5
1228	N	N	N		+3.5	N		183	35
574	D	+	+		-4.	+		170	36
575	D	+	+		-2.	+		174	37
1226	N	N	+		+0.5	N		166.5	40.5
592	N	N	N		+4.	+		169	38
579	D	+	-		-5.	+		169	29
882	N	N	N		+6.	N		170	39
1287	D	N	N		+3.5	N		176.5	39
1213	N	+	-		-2.	+		169	39.5
775	N	N	N		+8.	N		176	42
1088	N	N	N		+4.5	N		177	29.5
1208	D	+	N		-0.5	+		182.5	36
904	N	+	N		0	N		166	42
1172	N	N	+		+2.5	N		189	35.5
1231	N	N	N		+0.5	N		180	33.5
1201	N	N	N		+3.5	N		174.5	39.5
1045	N	N	+		+0.5	N		177	33.5
1059	N	+	+		+3.5	+		171.5	41.5
1060	N	N	N		+4.5	N		178.5	41
1240	N	N	N		+2	N		171	35
520	N	+	-		+4.	+		172.5	37.5
934	D	+	N		+4.5	+		166.5	35.
402	N	N	-		+5.	N		183.5	37

Age Group: 12 yrs Sex: M N: 26 Type of Radiogram: Laterals

Case Number	DENTAL CHARACTERISTICS					CRANIO-FACIAL CHARACTERISTICS				
	Dentition	N D M	Overjet	Crowding	Incisor Inclin- ation	A - B Relation	Deep Bite	Jaw Relation to ANS	Facial Angle	Cranio Occlusal Angle
1028	D		+	N		-1.	+		176.5	33
509	N		N	N		0	N		171	32.5
508	N		N	N		+0.5	N		174	30
827	N		N	N		+8.0	N		185.5	35.
365	N		N	N		+3.0	N		173.5	39.5
258	N		N	N		+1.0	+		170.5	39
1288	D		+	N		+2.5	+		178	37.5
743	N		+	+		-3.	+		174	31
184	D		+	N		+6.	N		183.5	34.5
343	N		N	N		+0.5	N		177.5	36.5
345	D		+	N		-5.5	+		173	27
1160	N		+	+		+2.5	+		175	36
1291	D		N	N		-3.0	+		179	29
771	N		N	N		+2.0	N		176	33
965	N		N	N		-0.5	N		167.5	34.5
281	N		N	N		+6.5	N		173	36
1280	D		+	N		-5.5	+		180	27
729	N		N	+		+1.0	N		166.5	39
997	N		+	-		+0.5	+		178	34
1021	D		+	+		-11.0	+		166	38.5
780	D		+	N		-4.0	+		170.5	30
1017	N		N	-		+4.0	N		189	33.5
329	N		N	N		+1.0	N		183	30
1301	D		+	N		-3.	+		176	29
1257	N		N	N		-1.	N		178	33.5
979	N		N	N		+6.	N		177	39

Age Group: 12 yrs

Sex: M

N: 26

Type of Radiogram: Laterals

DENTAL CHARACTERISTICS						CRANIO-FACIAL CHARACTERISTICS			
Case Number	Dentition N D M	Overjet	Crowding	Incisor Inclination	A - B Relation	Deep Bite	Jaw Relation to ANS	Facial Angle	Cranio Occlusal Angle
404	N	N	N		0	N		170.5	33
1264	N	N	N		-1.5	N		172	37.5
527	N	N	-		+0.5	N		180	28
1143	D	N	N		+4.5	N		174.5	43
1293	N	N	N		+4.5	N		180	35.5
1131	N	N	N		+2.	N		184	34.5
531	N	N	N		+7.	N		188.5	30
1080	D	N	N		-2.	N		169.5	35.5
1022	N	N	N		-1.	N		169.5	36.
882	D	N	N		-2.	N		171	39
670	D	N	N		+0.5	N		174.5	33
1188	N	N	N		+1.	N		176.5	37.5
1189	D	N	N		+1.	N		168.5	41.5
994	D	N	N		+6.	N		175	30.5
330			N		?			?	?
1020	N	N	N		+2.5	N		174	34.5
750	N	N	-		+1.	N		178	35.
684	N	N	N		+3	N		176	36.5
909	D	N	N		+3.5	N		172	39
1046	N	N	N		+2.	N		173	37
379	N	N	N		+2.	N		175.5	39
715	N	N	N		+5.	N		174	38.5
995	D	N	N		0	N		166	44.5
1267	N	N	N		-0.5	N		173.5	39.5
1089	N	N	N		-2	N		180	29.5
519	D	N	N		-4.5	N		173.5	32

BURLINGTON ORTHODONTIC RESEARCH: Analysis of Cranio-Facial Characteristics
Age Group: 12 yrs Sex: M N: 9 Type of Radiogram: Laterals

DENTAL CHARACTERISTICS							CRANIO-FACIAL CHARACTERISTICS			
Case Number	Dentition	N D M	Overjet	Crowding	Incisor Inclination	A - B Relation	Deep Bite	Jaw Relation to ANS	Facial Angle	Cranio Occlusal Angle
1224	N		+	-		-2.	+		171.5	35
1134	N		N	N		+3	N		172	39
1071	D		+	N		-1.5	+		177.5	35.5
461	D		+	N		-4.	+		173.5	32.5
226	N		N	+		+4.	N		178.5	40.5
499	D		+	N		-3.	+		171	35.5
1295	M		N	N		?	N		?	?
1285	N		N	N		+5	N		170.5	40
999	D		N	+		+1.5	N		171	37.5

BURLINGTON ORTHODONTIC RESEARCH: Analysis of Cranio-Facial Characteristics Page 1
 of
 Age Group: 12 yrs Sex: F N: 24 Type of Radiogram: Lateral 4 pages

Case Number	DENTAL CHARACTERISTICS				CRANIO-FACIAL CHARACTERISTICS			
	Dentition	Overjet	Crowding	Incisor Inclination	A - B Relation	Deep Bite	Jaw Relation to ANS	Cranio Occlusal Angle
776	N	N	N		+3.	N		175
442	D	+	+		-4.5	+		180
243	N	N	N		-3.	N		171.5
1161	D	+	-		+3	+		?
998	N	N	N		-3.5	N		171.5
833	D	+	N		+0.5	+		171
902	N	N	N		+2.	N		176.5
1084	D	N	+		+4.	N		172.5
306	N	+	-		+2.5	+		184.5
1292	N	N	N		+8.5	N		181.5
580	D	N	+		-3.5	+		164.5
797	D	+	+		+2.0	N		175.5
452	D	+	+		+7.5	+		165.
1222	D	+	+		0	+		171.
807	D	+	N		-1	+		174.
884	D	+	+		0	+		171.
1284	N	N	+		+3.5	-		175.5
200	D	+	+		-4.0	+		176.5
309	N	N	N		-1.5	N		176.
181	D	+	+		+3.0	+		168.5
767	N	N	N		+1.	N		177.5
1272	N	N	+		+3.	N		180
993	N	N	N		+2.5	N		169
688	N	N	N		-1.	N		172

Age Group: 12 yrs Sex: F N: 25 Type of Radiogram: Laterals

Case Number	DENTAL CHARACTERISTICS					CRANIO-FACIAL CHARACTERISTICS				
	Dentition	N D M	Overjet	Crowding	Incisor Inclination	A - B Relation	Deep Bite	Jaw Relation to ANS	Po Facial Angle	Cranio Occlusal Angle
364	N		+	+		=2.	+		171.5	35.
1061	N		N	N		=1.5	N		168.5	33.5
1036	D		+	N		-2.	+		164.	39.5
819	N		N	N		+2.5	N		175.	35.
1092	N		N	N		+6.	N		174.	41.
1140	D		+	N		-2.	+		173	29.
824	D		+	N		-0.5	+		170	33.5
1286	N		N	N		+8.	N		176.5	42.5
654	N		N	N		+4.	N		192.	26.
362	N		N	N		-1.	N		174	37
406	N		N	N		+1.5	N		174	35.5
1215	N		N	N		+1.	N		174	37.
1043	N		N	N		+6.	N		182.5	33.5
535	N		N	N		+4.	N		180.	34.
1247	N		N	N		=2.	N		175.	35.
1223	D		+	+		-10.	+		170	27
689	D		+	N		+0.5	+		174.5	33
1253	N		N	N		+0.5	N		174.5	33
1300	N		N	N		+3.0	N		191	30.5
1279	N		N	N		+0.5	N		172	39
823	N		N	N		-5.5	N		171	32.5
969	N		N	N		+0.5	N		171	39
1302	N		N	N		+2.	N		182	30.5
1290	N		N	N		=2.	N		174	31.5
1245	D		+	+		-4.	+		170	30.5

Age Group: 12 yrs

Sex: F

N: 26

Type of Radiogram: Laterals

Case Number	DENTAL CHARACTERISTICS					CRANIO-FACIAL CHARACTERISTICS			
	Dentition	Overjet	Crowding	Incisor Inclination	A - B Relation	Deep Bite	Jaw Relation to ANS	Facial Angle	Cranio Occlusal Angle
228	N	N	+		-0.5	N		180	32.5
314	D	+	+		-6.5	+		169	30
929	D	+	N		-1.5	N		168	29.5
802	D	N	+		-5.5	+		177.5	25.5
714	D	+	N		-2.5	+		180	31
752	N	+	-		-5.0	N		170.5	28.5
150	N	N	N		+10.	N		192.5	31.5
400	N	+	-		-1.5	+		178	27
980	N	N	N		+1.5	N		179	33.5
147	N	N	N		+6.5	N		181	39
988	N	N	N		+3.5	N		179	37
1157	M	-	+		+1.0	+		174	36.5
1198	N	N	N		0	N		176.5	31
1054	D	+	N		-1.5	+		170	37
146	N	N	N		-1.	N		175.5	32
521	N	N	N		0	N		178	33.5
1130	D	+	+		-4.5	+		173	33
443	N	+	N		+1.	N		176	35
1238	D	+	+		0	N		177	36.5
581	N	N	N		+1.5	N		182.5	31
1229	N	N	N		+4.5	N		175	39.5
953	D	+	+		-4.	+		178.5	29.5
1248	D	N	+		-2.	N		172	37
1262	N	N	N		+1.	N		180	35.5
985	N	N	N		-7.	N		164.5	32.5
565	N	N	N		+3.	N		177.5	38.5

Case Number	DENTAL CHARACTERISTICS						CRANIO-FACIAL CHARACTERISTICS			
	N Dentition D M	Overjet	Crowding	Incisor Inclin- ation	A - B Relation	Deep Bite	Jaw Relation to ANS	Po Angle	Facial Angle	Cranio Occlusal Angle
1289	N	N	N		+2.5	N			177	36
1203	D	N	N		+8.	N			?	?
7	N	N	N		+2.	N			191.5	31.5
1274	N	N	N		-4.5	N			176.5	34.0
1200	D	N	N		+4.	N			167.	35.5
800	D	N	N		+6.	N			180	44
1275	N	N	N		-3	N			176	44.5
1025	D	N	N		-4.	N			160	38.5
1299	N	N	N		-3.	N			174.5	30.5
927	N	N	N		+6.5	N			174.5	31.
1256	D	N	N		+6.	N			182.	38.5
1281	N	N	N		+4	N			161	49
1276	N	N	N		+1.	N			?	?
773	N	N	N		+3.5	N			169	43.5
586	N	N	N		-6.	N			174	41.5
236	N	N	N		-3.5	N			167.5	30.5
671	D	N	N		+4	N			167.	38
838	N	N	N		0	N			?	?
922	D	N	N		+1.5	N			177.5	31.5
444	N	N	N		-2.	N			173	41
757	N	N	N		-2.	N			175	34.5
1184	D	N	N		+1.	N			180	28.5
1260	N	N	N			N			173	39.5

VIII AN EVALUATION OF CRANIO-FACIAL CHARACTERISTICS IN
TREATED AND UNTREATED CASES

An Interim Report by: M. E. Hatton

The paper, "Cranio-facial Characteristics as Predisposing Factors in the Development of Malocclusion", (p.14 of the present report) serves to illustrate the relation which facial angle bears to A-B relation at various age levels and similarly the disposition of certain dental irregularities with respect to those two skeletal features. The observations on which that paper was based were derived from the four cross-sectional control samples, boys and girls at 6, 8, 10, and 12 years of age.

- The present paper is a report of comparisons which have been made so far between the cross-sectional samples mentioned above and the so-called serial treated cases, called here, the experimental samples.

- The characteristics which have been compared were facial angle (nasion, subnasale, pogonion) and A-B differences (the difference between the bony base of the lower incisors and that of the uppers projected onto the functional occlusal plane); and in addition four dental defects including, crowding, overjet, overbite and inharmonious arch relation. Crowding included situations in which tooth material exceeded available arch space; overjet was considered positive when the relation of the upper incisors to the lowers was in excess of 3 mm.; overbite was positive when the incisal edge of the upper incisors exceeded one-half the lower incisors; inharmonious arch relation (mesio-distocclusion) was based on the whole of the lower arch in its relation to the upper.

- It is true that the prevalence of several dental defects have been determined previously by other investigators and noted in earlier reports. Nevertheless, not only because facial angle had not been hitherto evaluated,

but also since A-B relation was to receive a quite different evaluation (see p. of the present report), under the circumstances, the differences in techniques of appraisal caused both Dr. Harvold and the writer to conduct their own observations on the four dental characteristics.

- Frequency distributions for facial angle and A-B relation are shown in Figures I to IV. No attempt has so far been made to explain any differences which may exist between the two groups of children.

- Table I shows the percentage frequencies of the four dental defects. In the controls, girls at the age of ten years show a decided drop in inharmonious arch relation, overjet and overbite; boys on the other hand show a reduction in only inharmonious arch relation and this at the later age of twelve years. Moreover, girls at twelve years indicate an increase in all four symptoms. A comparison between controls and experimental overall samples at eight years indicates that all four defects were reduced in their frequency in girls at this age; boys show a reduction in only crowding and overbite.

Although comparisons have been made between the overall control and experimental samples, both groups are in fact limited as to their true "experimental" and "control" nature. Obviously only the affected cases in the serial sample have been treated and clearly some individuals in the controls have had private treatment. For these and other reasons care must be exercised in drawing conclusions based on comparison between the two groups at this stage, lest they be assigned a spurious interpretation.

TABLE I PERCENTAGE FREQUENCIES OF FOUR COMMON MALOCCLUSION
MANIFESTATIONS IN DIFFERENT GROUPS OF CHILDREN

MALES

Cross Sectional Controls 4 Different Groups of Children					Serial (Experimental)			
Age (Years)	6	8	10	12	6 ^t ₁	8 ^t ₂	10	12
N		97	108	112	142	142		
Crowding		20.6	25.7	25.9	7.0	19.0		
Overbite		30.9	34.9	31.1	14.7	27.5		
Overjet		34.0	31.2	31.1	16.1	38.0		
Inharmonious Arch Relation		26.8	24.8	20.5	16.1	38.0		

N - Sample size

6^t₁ - at 6 years - 31% of sample had received preventive-inter-
 ceptive therapy

8^t₂ - at 8 years - 59% of sample had received preventive-inter-
 ceptive therapy

FEMALES

Cross Sectional Controls 4 Different Groups of Children					Serial (Experimental)			
Age (Years)	6	8	10	12	6 ^t ₁	8 ^t ₂	10	12
N		123	105	96	120	120		
Crowding		29.3	30.5	32.3	13.3	27.5		
Overbite		35.8	23.8	33.3	14.2	24.1		
Overjet		34.2	20.0	34.4	18.3	31.0		
Inharmonious Arch Relation		30.8	13.3	31.2	14.2	20.0		

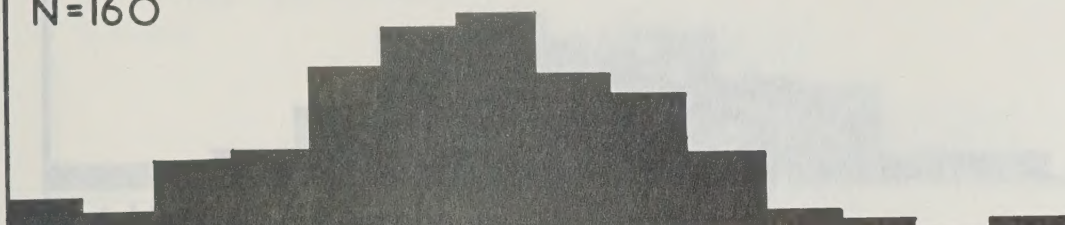
N - Sample size

t₁ - at 6 years 39% of sample had received preventive-inter-
 ceptive therapy

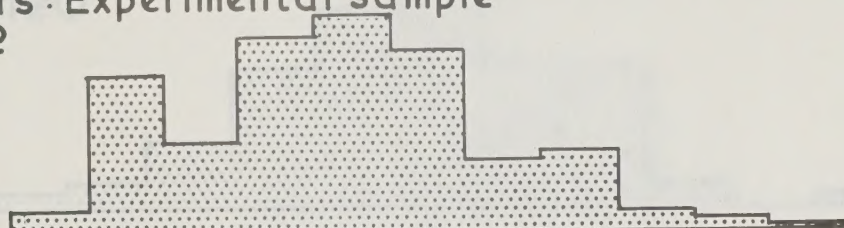
t₂ - at 8 years 64% of sample had received preventive-inter-
 ceptive therapy

MALES: FACIAL ANGLE

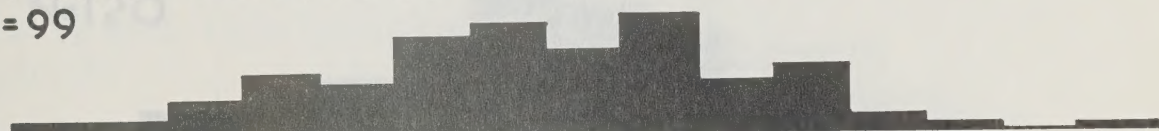
6 YEARS: CONTROLS
N=160



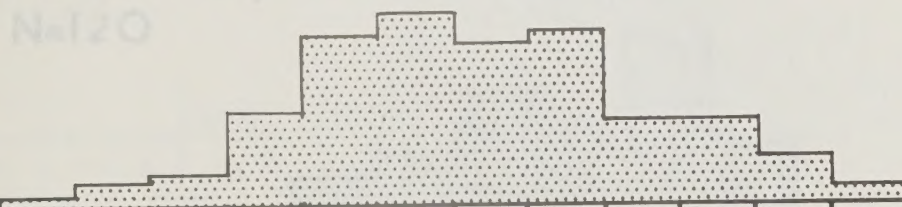
6 Years: Experimental sample
N=142



8 YEARS: CONTROLS
N=99



8 Years: Experimental sample
N=142



156-75 | 160-75 | 164-75 | 168-75 | 172-75 | 176-75 | 180-75 | 184-75 | 188-75
158-75 | 162-75 | 166-75 | 170-75 | 174-75 | 178-75 | 182-75 | 186-75
Degrees

FEMALES: FACIAL ANGLE

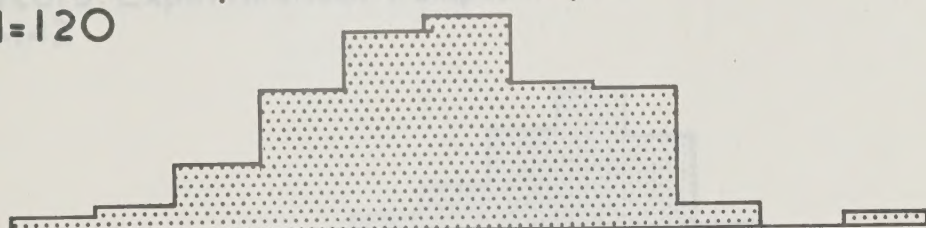
6 YEARS: CONTROLS

N=119



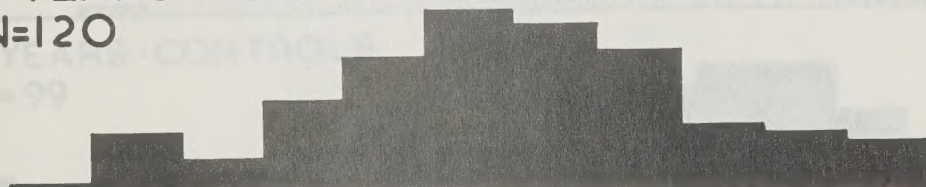
6 Years: Experimental sample

N=120



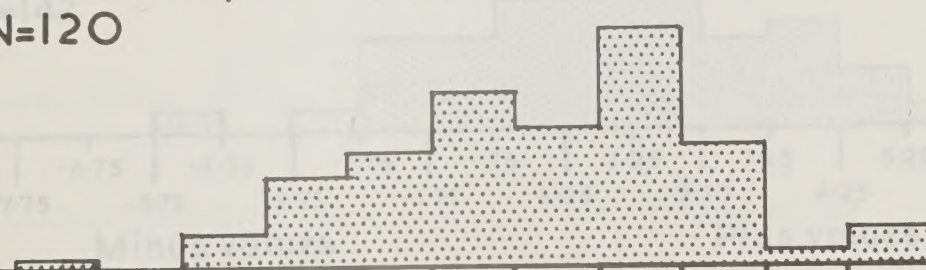
8 YEARS: CONTROLS

N=120



8 Years: Experimental sample

N=120

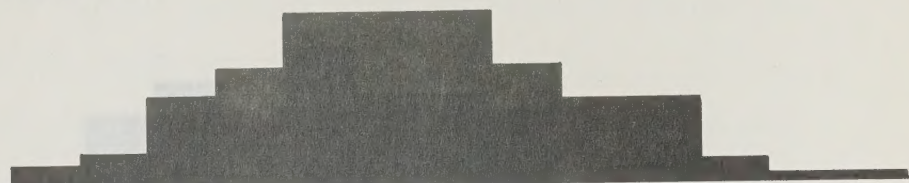


156.75 160.75 164.75 168.75 172.75 176.75 180.75 184.75
158.75 162.75 166.75 170.75 174.75 178.75 182.75

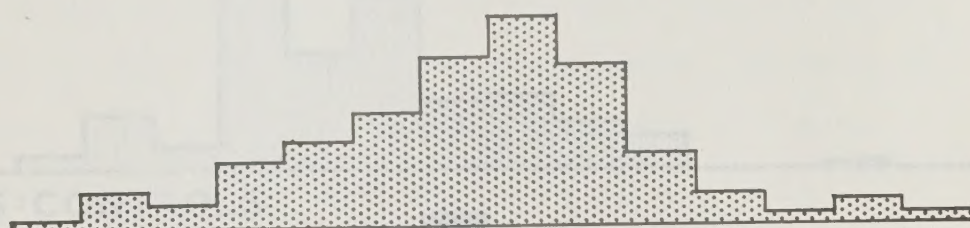
Degrees

MALES: A-B RELATION (mm.)

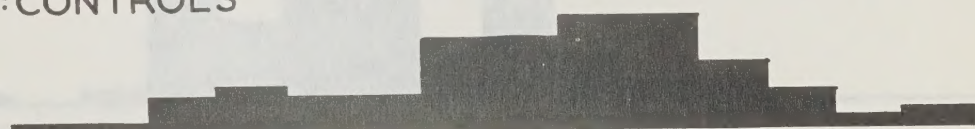
6 YEARS: CONTROLS
N=160



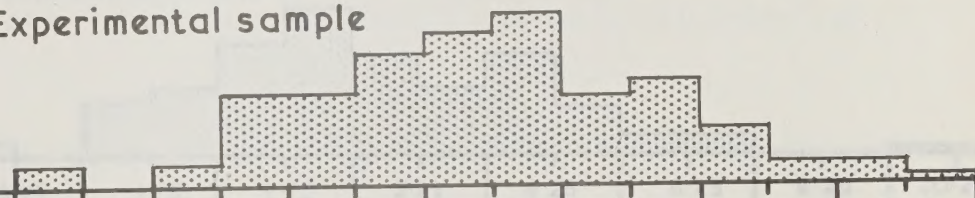
6 Years: Experimental sample
N=142



8 YEARS: CONTROLS
N=99



8 Years: Experimental sample
N=142



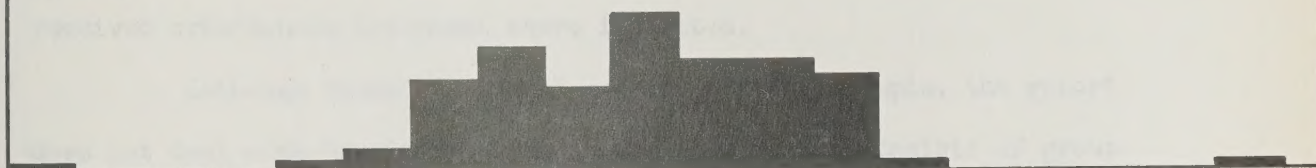
-8.75 -7.75 -6.75 -5.75 -4.75 -3.75 -2.75 -1.75 -0.75 +0.25 1.25 2.25 3.25 4.25 5.25 6.25 7.25 8.25

Minus values Plus values

FEMALES: A-B RELATION [mm]

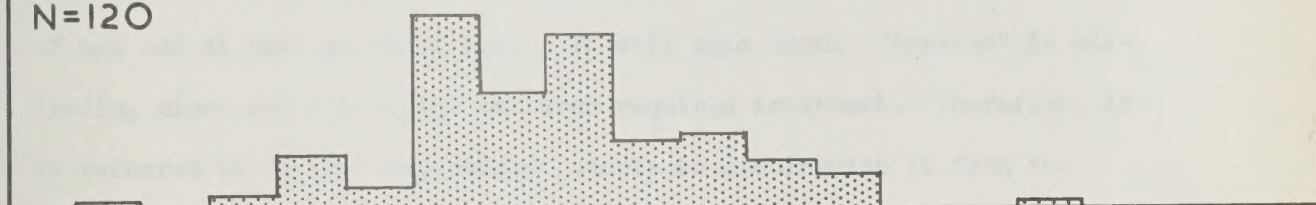
6 YEARS: CONTROLS

N=119



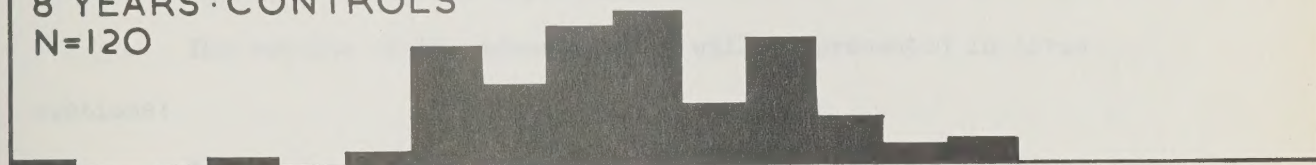
6 Years: Experimental sample

N=120



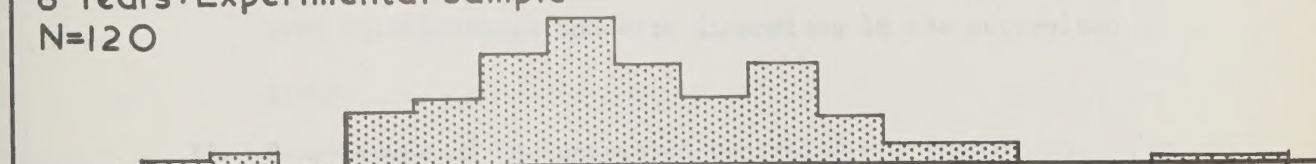
8 YEARS: CONTROLS

N=120



8 Years: Experimental sample

N=120



-7.75 -5.75 -3.75 -1.75 +.25 2.25 4.25 6.25 8.25 10.25 11.25
-6.75 -4.75 -2.75 -.75 1.25 3.25 5.25 7.25 9.25 11.25
Minus values Plus values

IX TOOTH SIZE, SPACING-CROWDING, ARCH RELATIONSHIPS AND ARCH DIMENSIONS IN THE ORTHODONTICALLY SUPERVISED GROUP.

This report prepared by W. S. Hunter

INTRODUCTION

Purpose - The purpose of this investigation was to describe and assess the teeth and their relationships to each other in the group of children who received orthodontic treatment where indicated.

Although there are annual records for this sample, the report does not deal with the information as serial data but consists of group comparisons utilizing the information on the serial group at six years of age and at nine years of age. To call this sample "treated" is misleading since not all of the children required treatment. Therefore, it is referred to as the "supervised" sample to distinguish it from the "control" sample presented in Report #5.

The results of the investigation will be presented in three sections:

- I. A descriptive summary of tooth size, spacing-crowding, arch relationships and arch dimensions in the supervised group.
- II. Comparisons of the untreated control group (Report #5, pp.78-114) with the supervised sample.
- III. Some comparisons within the supervised group of not treated and treated subjects.

Method - The method of obtaining the measurements was identical with that detailed in Report #5, Pp.79-85, except for antero-posterior relationship II where the values were obtained by direct measurement. Since this was frequently found to be impossible, this simpler method may be just as unsatisfactory as the indirect method used previously (Report #5, p.80).

All computations were performed on the IBM .650 installation at the Computation Centre, University of Toronto. The help of Dr. Gotlieb and his staff is much appreciated.

I. DESCRIPTIVE SUMMARY OF THE TEETH AND THEIR RELATIONSHIPS IN THE SUPERVISED GROUP.

Age Since the sample described here was diminished by fewer than thirty cases from age six to age nine, no case for which the nine year records were missing was measured at age six. Therefore, there are 139 males and 115 females at both ages. This information is summarized in Table 1 where it will be seen that the six year sample as a whole is two to three weeks less than six years of age, while the nine year sample is one to two weeks more than nine years of age with very small variabilities at both ages.

Reliability Tables 2, 3, and 4 show the comparisons between first and second measurements on twenty subjects. These were spaced approximately twelve subjects apart throughout the sample and the second measurement was made after approximately 12 other cases had been measured.

In Tables 2 and 3 only one value, that for the maxillary right second primary molar, exceeds an average of .10 mm. It is a statistically significant difference and it is possible that at age six in the absence of the permanent molar, measurements are not accurate for this tooth. However, in the other seven comparisons for this tooth position, the values are within acceptable limits. Although the value for the mandibular left cuspid is statistically significant, the average difference is less than .10 mm. and would seem to be of no practical significance.

In Table 4, the six year value for Overjet I and for Molar and Cuspid Relationships on the right side are significant but less than .50 mm. in size. The fact that both Mean and Standard Deviation values associated with the right side cuspids are rather high, suggests that one case was quite divergent. These measures are not as accurate as the tooth size values since 8 of the 15 are influenced by the way in which the casts are fitted together. This is frequently quite difficult at these ages since the primary molars do not, as a rule, interdigitate in a definite way.

In general, the error estimates are a shade larger for the serial group than for the control group (Report #5 pp. 94-108). However, in only one instance do the average values exceed .10 mm. which is the intended accuracy of the instrument used.

Types of Measurements Made -

Tables 5 and 6 are summaries of the various types of measurements made. The categories are defined as follows:

1. not measured - tooth was not present, or if present was badly carious, poorly restored, or banded.
2. primary teeth - this means that the primary tooth was either non-carious or restored in such a fashion that the mesiodistal diameter was not disturbed or that caries or restoration could not be detected on the cast.
3. permanent teeth - identical with (2) above, except that it refers to permanent teeth.
4. restored primary teeth - refers only to proximal restorations and does not include badly made restorations which would alter the mesiodistal diameter from its original value.
5. antimere used - assuming a high degree of symmetry in mesiodistal tooth diameter, the value for the same tooth on the opposite side was used where it could not be obtained directly because of absence, caries, restorations or bands.

6. unreliable - this was sparingly used for partially erupted teeth.
7. restored secondary teeth - see #4 above.
8. carious - used when the process of decay affected the mesiodistal diameter to a non-measureable extent only.
9. sliced - the present sample contains nearly sixty cases in which some form of serial extraction is being performed. In half of these, the primary cuspids have been sliced to reduce their diameter. The reduced diameter was recorded in this category.
10. earlier record - this category was created to exploit the fact that there are records at age four for most of the sample so that in the event of decay, loss or extraction, a measure of the actual tooth size could almost always be obtained from earlier records.

Effect of Restorations in Primary Teeth on Measurements.

Table 7 was prepared to help answer the question "What effect does the inclusion of primary molars with proximal restorations have on the spacing-crowding analysis?" In only one comparison out of 32 is the average value for restored teeth smaller than the average size for non-carious, unrestored primary molars. Twenty-two out of thirty-two comparisons are statistically significant and the average value of the difference is 0.29 mm. for the sample at age six and 0.16 mm. at age nine. Therefore, in this sample at least, teeth having proximal restorations are larger on the average, than unrestored (and hence non-carious) teeth.

Two possible explanations for this finding were considered. The first is that teeth with proximal restorations (which are a reflection of caries attack) are as a group, slightly above average in size. To test this hypothesis, the data were studied in three segments per arch - the anterior segment containing the incisors and the left and right posterior segments the cuspids and primary molars.

Since the incisors at age nine are virtually caries free and unrestored in this sample (Table 5) the general correlation in tooth size (assumed to exist) should reflect the phenomenon under consideration in a comparison of the sum of the four incisor tooth widths for unrestored, (non-carious) dentitions and restored (carious) dentitions. In order to make the comparison more vigorous, all cases with missing measures and those with bicuspid present, were deleted from the "restored" tooth sample and the cephalograms for the non-carious, unrestored sample were checked to eliminate any proximal restorations which had escaped detection on the casts. Admittedly, such restorations would have no measureable effect on the tooth size values but it was felt desirable to check the point. Out of 65 cases there were 6 such cases which were deleted.

Table 8 contains the results of these comparisons and shows that arches having restorations are made up of teeth that are on the average, slightly larger than unrestored non-carious arches.

The second possibility considered was that during the process of restoration, the proximal contours of such teeth were enlarged by overpacking of the amalgam. While it seemed unlikely that such "over-packed" teeth were measured to begin with, it was thought desirable to check this since whether the tooth was measured or not, was a matter of judgement on the investigator's part at the time of measurement. Therefore, cases having restorations on one side only were studied so that the restored tooth material might be compared, in the same individuals, with non-carious unrestored tooth material. Again, it was thought best to make the comparison as rigorous as possible under the circumstances and all cases for which the values for the unrestored side were difficult to obtain or were obtained from earlier records and of course, values for permanent teeth were deleted. Table 9 contains these results and it is # - see explanation of "not measured" category p.33.

apparent that overpacking is not a potent factor since the restored side is smaller 2 out of 4 times, identical in size once and .08 mm. larger once.

These two studies give a partial explanation to the similar finding in Report #5 (page 88) to the effect that restored teeth tend on the average to be larger than unrestored (non-carious) teeth and further that the arches in which the larger teeth are found are also larger. The latter is so because restorations tend to be found in larger teeth, which in turn are found in larger arches, there being presumably a low positive correlation between tooth size and arch size.

Measurements of Various Characteristics

Tables 10 and 11[#] show the average tooth size values for unrestored (non-carious) primary teeth in the supervised group. We are unable to explain the absence of a sex difference for the maxillary second primary molars on the left side.

Tables 12 and 13 contain the average tooth size values for unrestored (non-carious) permanent teeth in the supervised group.

Table 14 contains the means for arch length and total tooth material by quadrant and arch for maximum data (using restored, carious, opposite side and earlier records for tooth size).

Table 15 contains the same information for dentitions having neither restorations nor missing teeth.

Tables 16 and 17 contain the average values for spacing-crowding by quadrant and by arch for all data and for the sample reduced by deletion of arches having restorations or missing measures.

Tables 10 through 17 in this report are analogous to Tables 8 through 15 for the control group (pp. 100-107) in Report #5.

Three Segment Analysis

Inasmuch as the analysis of spacing-crowding by quadrant does not separate anterior conditions from posterior conditions, a further analysis was undertaken. For this analysis, each arch was divided into three segments as follows: (1) from the distal of the left primary second molar or bicuspid to the mesial of the left cuspid. (2) from the mesial of the left cuspid to the mesial of the right cuspid (3) from the mesial of the right cuspid to the distal of the right primary second molar or bicuspid.

While the cuspid may or may not be considered an anterior tooth, it is the space (if any) distal to it which is of interest in this analysis. Such a space ought logically to be in the posterior segment, but was included in the measurement from the mesial of the cuspid to the mesial of the first primary molar or bicuspid in these studies. Therefore, the cuspid is included in the posterior segment. Since this analysis did not appear in Report #5 for the control sample, the values for the control sample and supervised sample are presented here in successive tables.

Tables 18 and 19 contain the three segment information for control and supervised samples respectively for maximum data for arch length and tooth material.

Tables 20 and 21 contain the three segment information for control and supervised groups respectively, for spacing-crowding utilizing all available data.

Tables 22 and 23 contain the eight arch relationship measures and six measures of arch length and width for the supervised sample at six and nine years of age respectively.

II COMPARISONS OF THE CONTROL SAMPLE WITH THE SUPERVISED SAMPLE

The tables in this section should be seen as a preliminary examination of the overall comparability of the control and supervised groups and as a screening test for possible presence of gross changes attributable to the treatment. It is assumed however that treatment of such a variety of symptoms as were encountered would result in a masking of individual changes resulting from treatment. The comparison of general average values by means of the Student-Fisher 't' test is not necessarily appropriate to the problem of testing specific treatment effects on a few cases and incorrect inferences from these comparisons must be avoided.

In each table the average values for the supervised sample are subtracted from the corresponding values for the control sample. A positive value for the difference, therefore means that the control sample average is larger and a negative value that the supervised sample average is larger. In general a 't' value of 1.98 or more is significant at the 5% level.

Comparisons of Mesiodistal Tooth Diameters.

Table 24 is a comparison of the size of primary teeth in the two samples. It will be noted that 7 out of 8 comparisons for the second primary molar show it to be larger in the control sample. This difference is approximately .14 mm. in the maxilla and .18 mm. in the mandible. The error control study (Table 2) suggests that some of this could be investigator bias (particularly in the maxillary right quadrant) although why such a bias should manifest itself only in this tooth position is difficult to explain. Furthermore, as has been noted in the discussion on proximal restorations, teeth having such restorations tend to be larger than unrestored, non-carious teeth and certainly more of these larger teeth

have been deleted from the supervised sample than from the control sample. In other words, although the caries attack rate may have been the same for both groups, the control group received less dental care and thus had fewer restorations to be deleted. This would account for the larger number of primary molars measured for the control group, many of them with incipient caries and concomitantly larger.

The above theory wavers somewhat when the first primary molars, which at age six have a higher restoration rate than the second primary molars (Table 5) are considered. Although the trend is the same, the intensity is less, when if the above theory is correct, the intensity should be greater. In any case, the differences between the size of the second primary molars in the control and supervised samples does not as was noted above, exceed .20 mm. on the average and this may not be sufficient to interfere with the evaluation of spacing-crowding.

Table 25 shows similar comparisons for permanent teeth. No significant differences are seen.

Comparisons of Arch Length and Tooth Material

Table 26 is a comparison of the two groups with respect to arch length and tooth material by arch. It may be noted that arch length is greater for the supervised group for both males and females at both ages except for the mandibular arch of nine year old females, while total tooth material is without exception, less for the supervised group. This ought to result in greater average spacing for the supervised group and Table 27 shows that except for the mandibular arch at nine years of age, this is so.

It should be explained that it is not possible to compare directly the Arch Length - Tooth Material tables and the Spacing-Crowding tables unless the samples for Arch length and Tooth Material are the same

size. Thus, in the control sample at age nine, the average arch length is for approximately 30 more subjects than is the average tooth material value. Since spacing-crowding is computed for each subject using both arch length and tooth material, these 30 subjects do not appear in the spacing-crowding values, since they did not have a tooth material value for computation of spacing-crowding. However, tables from which subjects with restored teeth have been deleted may be matched up.

Table 28 contains the 3 segment comparisons of control and serial groups for arch length and tooth material. It may be noted that with 3 exceptions, tooth material is less for the supervised group for both sexes and at both ages, while arch length is more often greater for the supervised group. At age nine, the arch length values for the anterior segment of the supervised group are significantly greater than those for controls in 3 out of 4 comparisons and almost significant in the 4th. This is apparently at the expense of the posterior segments. When this is followed into Table 29 (spacing-crowding in 3 segments) it is seen that there is significantly more spacing for both males and females at age nine in the anterior segment of the supervised group. While the same trend is visible at age six, it is not nearly so prominent. Perhaps this is indeed a result of treatment.

Comparisons of Arch Relationship and Arch Dimension Measures

Tables 30 and 31 are comparisons of control and supervised groups using arch relationship and arch dimension measures. The significant 't' values for Overjet II merely reflect a different method of measurement (it was found impossible to obtain this measure accurately with gauge available). Similarly, the values for palate depth are not to be trusted as this too was found difficult to measure within the limits of accuracy imposed.

There remains for discussion in Table 30, the significantly different values for left cuspid and midline for males. Since the differences are only a little larger than the error study values (Table 4) they could well be largely a measurement artefact. Table 31 shows no significant differences except for palate depth which cannot at the moment be explained. It might well be due to some error or bias of the method.

III COMPARISONS WITHIN THE SUPERVISED GROUP

Since early treatment of malocclusion in this project involves the concepts encompassed by interception and guidance (which include maintenance of space, space regaining, habit control or elimination of thumb and finger habits, correction of crossbites and the control of tooth-base disharmonies by the removal of teeth, to name a few of the procedures encompassed) by means of appliances utilizing a minimum or absence of bands, it follows that a variety of treatment methods were utilized, each on a relatively few cases. Analysis of treatment then, cannot be a simple matter. It is further complicated by the appearance of a variety of symptoms in most subjects. In the preliminary approach to the problem it was decided that the supervised group ought to be divided and compared according to whether they had received some therapy or not. Since the analysis in general leads up to a measure of spacing-crowding, it was decided that subjects for whom extraction of 2 or 4 permanent bicuspids is planned or has occurred, should also be considered separately because these subjects naturally would be expected to have excessive crowding. Thus the members of the clinical staff were asked to divide the subjects under treatment into three groups: 1) treated - no extraction of permanent teeth contemplated 2) treated - extraction of permanent teeth definitely planned 3) treated -

borderline with respects to extraction. Since the last group included only 8 males and 7 females, the analysis for these subjects does not appear in the tables.

Arch Length and Tooth Material Comparisons

Table 32 shows the total arch length and tooth material by arches for untreated, treated non-extraction and treated extraction groups. Note the similarity between the not treated and treated non-extraction groups as compared with the much smaller arch lengths and greater tooth material values for the extraction groups. It should be remembered that for subjects whose primary cuspids had been extracted (as part of the serial extraction procedure) a value for cuspid size was obtained from earlier casts and substituted. Therefore, the crowding for this group (Table 33) is theoretical in that up to 15 mm. of space will be created by the removal of bicuspid.

Table 34 shows the arch length and tooth material averages in 3 segments per arch. Comparison of the various totals for anterior tooth material (the sum of the mesiodistal tooth diameters of the four incisors) for non-carious (no restorations) cases reveals that the sum of the widths of these teeth is indeed greater in the extraction group by one to two millimetre than in the untreated and non-extraction groups. This is of course, to be expected. What is disconcerting, is that the corresponding arch length measurements are also larger. The results of this are seen in Table 35 (spacing-crowding in 3 segments per arch) where a pattern of increased anterior segment spacing, apparently at the expense of the posterior segments, is seen for the extraction group.

The Treatment Groupings Projected Back to Age Six

Finally, these same subject groupings were considered at age six in an effort to evaluate the average changes. Table 36 contains the arch length and tooth material information for the same groups of subjects as seen in Table 34. The numbers involved differ slightly only because of more complete dentitions (hence fewer missing measurements) at age six. The anterior segments from Table 36 are not comparable with those of Table 34 since there are permanent incisors in the one and primary incisors in the other. However, in the posterior segments, tooth material is essentially unchanged, while arch length has diminished in every instance. Consideration of Table 18 (similar information for the entire control sample) shows that the same trend occurs in untreated material. The only reversal of this trend is found in the extraction group where maxillary anterior segment spacing has been enhanced. The non-extraction group has also more maxillary anterior spacing than would be expected on the basis of the untreated control sample.

Table 38 contains the treated versus not treated comparisons for arch relationships at age nine and Table 39 the information for the same subject groupings projected back to age six. Here we find that the average overjet and overbite have increased for all groups from age six to age nine and the molar relationships have become more Class II. A comparison of Tables 17 and 18 from Report #5 (pp.109-110) which show similar information for the control sample at ages six and nine demonstrates that overjet and overbite increase from six to nine and molar relationship becomes more Class II. On the other hand, cuspid relationship becomes more Class I. In the Supervised group cuspid relationship has improved in the untreated group (less Class II), is a bit more Class II in the treated non-extraction and is much more Class II in the extraction

group. Arch length has increased in all groups except for the lower arches of the extraction group. Arch width patterns show no change from the expected pattern of increase.

SUMMARY OF FINDINGS

Some evidence has been found that the average tooth dimensions for persons having proximal restorations tend to be slightly larger than those for persons with unrestored (non-carious) groups of teeth. This suggests that the caries incidence is higher on the average, for persons with large teeth than it is for those with small teeth. Whether this is a function of structure or of form is not yet known but most likely both contribute.

Comparisons of control and supervised groups in terms of average values revealed the second primary molars of the control group to be significantly larger than those in the serial group. This difference between groups is also seen in total tooth material values which are systematically larger for the control group than for the supervised group. At six years of age there is also more spacing in the serial sample than in the control sample (Table 27). At nine there is definitely more spacing in the anterior segments of the supervised sample but at the expense of the posterior segments. This can be traced to the treated portion of the supervised sample and it is most peculiar that the cuspid relation does not show a congruous pattern. This increase in anterior spacing is the only gross difference attributable to treatment which can be detected in these comparisons of averages.

TABLE 1

Average age in months for the supervised sample.
used in this study at age six and at
age nine.

SIX YEAR GROUP	N	AVERAGE AGE IN MONTHS	S.D. m	S.D. s
MALES	139	71.54	0.10	1.15
FEMALES	115	71.28	0.14	1.46
TOTAL	254			
NINE YEAR GROUP				
MALES	139	108.34	0.07	0.81
FEMALES	115	108.25	0.08	0.81
TOTAL	254			

SUPERVISED SAMPLE

SIX YEAR GROUP

		LEFT			RIGHT		
N		Mean difference in mm.	S.D. m	't'	N	Mean difference in mm.	S.D. m 't'
MAXILLA							
I ₁	21	.000	----	----	21	.019	.020 0.95
I ₂	21	-.019	.022	0.85	21	.019	.022 0.85
C	21	.038	.058	0.65	21	.005	.020 0.24
P ₁	21	.062	.035	1.79	21	.029	.022 1.28
P ₂	21	-.052	.033	1.58	21	.105	.044 2.40 [#]
M ₁							
MANDIBLE							
I ₁	20	.000	.022	----	20	.020	.020 1.00
I ₂	20	.010	.014	0.71	20	.005	.014 0.35
C	20	-.080	.028	2.83 ^{##}	20	.025	.026 0.95
P ₁	20	-.025	.022	1.12	20	.015	.044 0.34
P ₂	20	-.075	.050	1.50	20	.020	.049 0.41
M ₁							
ARCH MEASURES							
MAXILLA							
I ₁ -I ₂	20	.025	.046	0.55	20	.045	.051 0.88
C	20	-.080	.032	2.53 ^{##}	20	-.085	.039 2.20 [#]
P ₁ -P ₂	20	.020	.035	0.58	20	.005	.028 0.18
MANDIBLE							
I ₁ -I ₂	20	.005	.039	0.13	20	-.005	.042 0.12
C	20	-.075	.086	0.87	20	.055	.032 1.74
P ₁ -P ₂	20	.065	.059	1.10	20	.005	.041 0.12

significant at the 5% level of confidence

significant at the 1% level of confidence

TABLE 3 Summary of Error Control Study. - Supervised sample.

NINE YEAR GROUP

LEFT					RIGHT				
	N	Mean difference in mm.	S.D. m	't'		N	Mean difference in mm.	S.D. m	't'
MAXILLA									
I ₁	21	.033	.027	1.26		21	-.024	.020	1.19
I ₂	21	-.019	.025	0.78		21	-.014	.022	0.64
C	21	-.014	.027	0.54		21	-.014	.027	0.54
P ₁	21	-.019	.030	0.64		21	.000	.020	---
P ₂	21	-.029	.020	1.43		21	-.010	.027	0.36
M ₁	11	-.018	.051	0.36		10	-.040	.042	0.94
MANDIBLE									
I ₁	21	.005	.020	0.24		21	.014	.014	1.01
I ₂	21	-.024	.022	1.07		21	-.005	.017	0.27
C	21	-.014	.028	0.51		21	.024	.025	0.97
P ₁	21	-.090	.035	2.60 ^{##}		20	-.020	.030	0.67
P ₂	21	-.024	.028	0.84		21	.005	.036	0.13
M ₁	3	.133	.088	1.52		3	.000	.058	----

ARCH MEASURES

MAXILLA								
I ₁ -I ₂	21	.000	.049	---	21	.038	.066	0.57
C	21	.014	.037	0.38	21	-.071	.062	1.16
P ₁ -P ₂	21	-.048	.040	1.19	21	-.043	.025	1.75
MANDIBLE								
I ₁ -I ₂	21	.014	.040	0.36	21	-.038	.020	1.91
C	21	.040	.027	0.36	21	.024	.030	0.79
P ₁ -P ₂	21	-.029	.033	0.86	21	-.071	.033	2.15 [#]

- significant at the 5% level of confidence

- Significant at the 1% level of confidence

TABLE 4 Summary of error control study for the arch relationship and arch dimension measures. Every twelfth set of casts was measured twice with at least twelve sets of measurements intervening between first and second measures. SUPERVISED SAMPLE

SIX YEAR GROUP					NINE YEAR GROUP			
	N	Mean difference in mm.	S.D. m	't'	N	Mean difference in mm.	S.D. m	't'
OVERJET I	20	-.200	.081	2.48#	20	.155	.135	1.15
OVERJET II	19	.068	.089	0.77	20	.110	.145	0.76
MOLAR LEFT	20	-.010	.194	0.05	20	.085	.127	0.67
RELATION RIGHT	20	-.380	.176	2.17#	21	.048	.169	0.28
CUSPID LEFT	20	-.105	.094	1.11	21	.062	.137	0.45
RELATION RIGHT	20	-.330	.115	2.86##	21	-.005	.138	0.04
MIDLINE	19	-.074	.089	0.82	21	-.067	.070	0.96
OVERBITE	19	-.079	.039	2.04#	20	-.030	.033	0.91
ARCH MAX	20	-.040	.035	1.16	20	-.030	.033	0.91
LENGTH MAND	19	-.053	.061	0.87	21	.033	.035	0.94
ARCH MAX MOLAR	20	.030	.032	0.95	21	.038	.036	1.06
WIDTH CUSPID	20	-.605	.517	1.17	21	.048	.050	0.96
ARCH MAND MOLAR	20	-.080	.054	1.49	21	-.024	.704	0.03
WIDTH CUSPID	20	-.055	.032	1.74	21	-.019	.053	0.36
PALATE DEPTH	20	-.090	.069	1.31	21	.119	.071	1.68

- significant at the 5% level of confidence

- significant at the 1% level of confidence

TABLE 5 Summary of the types of teeth and measurements made for the SIX YEAR OLD SUPERVISED SAMPLE.

SIX YEAR OLD MALES												
MAXILLA	LEFT						RIGHT					
	di ₁ or I ₁	di ₂ or I ₂	c or C	dm ₁ or P ₁	dm ₂ or P ₂	M ₁	di ₁ or I ₁	di ₂ or I ₂	c or C	dm ₁ or P ₁	dm ₂ or P ₂	M ₁
	I ₁	I ₂	C	P ₁	P ₂		I ₁	I ₂	C	P ₁	P ₂	
Not measured	1					127	2	1				130
Primary teeth	116	133	138	103	107		113	131	136	107	107	
Permanent teeth	4					12	2					9
Restored 1 ^o teeth				28	20		1			23	18	
Antimere used	1				1		4	1	1		1	
Unreliable												
Restored 2 ^o teeth												
Carious	5	3		3	5		4	1		3	5	
Sliced												
Earlier record	12	3	1	5	6		13	5	2	6	8	
MANDIBLE												
Not measured		1	1			139	1	3	1			
Primary teeth	78	133	138	85	94		82	128	136	83	95	
Permanent teeth	49	2					49	3				
Restored 1 ^o teeth				39	30			1		45	34	
Antimere used	4						2	1	1	1		
Unreliable		1										
Restored 2 ^o teeth												
Carious				4	4				1	4	4	
Sliced												
Earlier record	8	2		11	11		5	3		6	6	
SIX YEAR OLD FEMALES												
MAXILLA	LEFT						RIGHT					
	di ₁ or I ₁	di ₂ or I ₂	c or C	dm ₁ or P ₁	dm ₂ or P ₂	M ₁	di ₁ or I ₁	di ₂ or I ₂	c or C	dm ₁ or P ₁	dm ₂ or P ₂	M ₁
Not measured					1	106						106
Primary teeth	87	106	111	79	76		93	103	112	76	81	
Permanent teeth	6	1				9	6	1		1		9
Restored 1 ^o teeth			1	33	35				1	27	28	
Antimere used	4	1	1	1				1			1	
Unreliable												
Restored 2 ^o teeth												
Carious	3	3	1		2		5	4	1	3	2	
Sliced												
Earlier record	15	4	1	2	1		11	6	1	8	3	
MANDIBLE												
Not measured				3	3	112				2	3	113
Primary teeth	53	100	111	62	75		49	95	112	63	72	
Permanent teeth	55	7				3	58	8				2
Restored 1 ^o teeth			1	37	26				1	40	28	
Antimere used	3	2		1	2		3	4		1	3	
Unreliable												
Restored 2 ^o teeth												
Carious			1	6	5					5	3	
Sliced												
Earlier record	4	6	2	6	4		5	8	2	4	6	

TABLE 6 Summary of the types of teeth and measurements made
for the NINE YEAR OLD SUPERVISED SAMPLE.

NINE YEAR OLD MALES

MAXILLA	LEFT						RIGHT					
	di ₁	di ₂	c	dm ₁	dm ₂	M ₁	di ₁	di ₂	c	dm ₁	dm ₂	M ₁
	or I ₁	or I ₂	or C	or P ₁	or P ₂		or I ₁	or I ₂	or C	or P ₁	or P ₂	
Not measured			1			46			1			56
Primary teeth	1	12	99	50	60		2	8	99	53	58	
Permanent teeth	137	112		7	1	91	136	113		5		79
Restored 1° teeth			1	56	61					59	59	
Antimere used		2	2	3	1			4	1	3	5	
Unreliable												
Restored 2° teeth						2						4
Carious			2	4	2				3	3	4	
Sliced			14						11			
Earlier record	1	13	20	19	14		1	14	24	16	13	
MANDIBLE												
Not measured	1		2			91	1	2	2			91
Primary teeth		3	87	44	57			2	87	45	56	
Permanent teeth	137	135	3	2	2	48	136	133	5	5	1	47
Restored 1° teeth	1		1	62	52		1		2	58	62	
Antimere used		1	2	2	2		1	1	1	8	3	
Unreliable				1								
Restored 2° teeth												1
Carious			1	2	2				1	1	2	
Sliced			23						20			
Earlier record			20	26	24			1	21	22	15	

NINE YEAR OLD FEMALES

MAXILLA	LEFT						RIGHT					
Not measured		1	2			42		2	3			55
Primary teeth		5	65	39	44			2	70	36	42	
Permanent teeth	111	106	4	13	8	68	111	106	5	17	8	58
Restored 1° teeth	1		1	38	53				1	42	54	
Antimere used			1	6	3		1	3	1	3	5	
Unreliable			1						1			
Restored 2° teeth	1					5	1					2
Carious		1	1	1	1					2		
Sliced			12						9			
Earlier record	2	2	28	18	6		2	2	25	15	6	
MANDIBLE												
Not measured			3	1	1	70			3	1	1	71
Primary teeth	1		38	32	41				41	29	37	
Permanent teeth	114	114	23	13	8	41	115	114	27	16	7	43
Restored 1° teeth			1	39	42				1	35	42	
Antimere used			3	3	5				3	8	9	
Unreliable												
Restored 2° teeth						4						1
Carious		1		1	1			1		1	1	
Sliced			11						10			
Earlier record			36	26	17				30	25	18	

TABLE 7 Summary of 't' tests of the difference in mesiodistal tooth diameter between Unrestored and Restored teeth found in the SUPERVISED sample. "dm₁" is deciduous first molar and "dm₂" is deciduous second molar.

		6 YEARS				9 YEARS			
LEFT SIDE		N	Mean in mm.	Diff.	't'	N	Mean in mm.	Diff.	't'
MAXILLA									
dm ₁	Unrestored	103	7.02	-0.29	2.67 ^{##}	50	6.89	- .29	2.81 ^{##}
male	Restored	28	7.31			56	7.18		
dm ₁	Unrestored	79	6.83			39	6.82		
female	Restored	33	7.23	- .40	4.34 ^{##}	38	7.06	- .24	2.12 [#]
dm ₂	Unrestored	107	8.77			60	8.69		
male	Restored	20	9.21	- .44	3.82 ^{##}	61	8.90	- .21	2.13 [#]
dm ₂	Unrestored	76	8.75			44	8.75		
female	Restored	35	8.86	- .11	1.15	53	8.66	0.19	0.89
MANDIBLE									
dm ₁	Unrestored	85	7.65			44	7.58		
male	Restored	39	7.90	- .25	2.78 ^{##}	62	7.77	- .19	1.84
dm ₁	Unrestored	62	7.49			32	7.43		
female	Restored	37	7.68	- .19	2.39 [#]	39	7.63	- .21	1.92
dm ₂	Unrestored	94	9.69			57	9.70		
male	Restored	30	9.99	- .31	2.99 ^{##}	52	9.82	- .13	1.44
dm ₂	Unrestored	75	9.57			41	9.50		
female	Restored	26	9.82	- .26	2.42 [#]	42	9.72	- .22	2.11 [#]
RIGHT SIDE		N	Mean in mm.	Diff.	't'	N	Mean in mm.	Diff.	't'
MAXILLA									
dm ₁	Unrestored	107	6.99			53	6.95		
male	Restored	23	7.22	- .24	2.19 [#]	59	7.09	- .14	1.59
dm ₁	Unrestored	76	6.80			36	6.94		
female	Restored	27	7.21	- .41	2.93 ^{##}	42	6.93	- .10	0.84
dm ₂	Unrestored	107	8.82			58	8.74		
male	Restored	18	9.18	- .36	2.95 ^{##}	59	8.96	- .22	2.44 [#]
dm ₂	Unrestored	81	8.75			42	8.71		
female	Restored	28	8.87	- .12	1.10	54	8.76	- .05	0.49
MANDIBLE									
dm ₁	Unrestored	83	7.78			45	7.70		
male	Restored	45	7.96	- .18	2.1	58	7.95	- .24	2.45 [#]
dm ₁	Unrestored	63	7.54			29	7.59		
female	Restored	40	7.92	- .38	4.01 ^{##}	35	7.75	- .17	1.45
dm ₂	Unrestored	95	9.66			56	9.68		
male	Restored	34	9.99	- .32	3.12 ^{##}	62	9.92	- .24	2.47 [#]
dm ₂	Unrestored	72	9.58			37	9.61		
female	Restored	28	9.87	- .29	2.78 ^{##}	42	9.78	- .17	1.54

- significant at the 5% level of confidence

- significant at the 1% level of confidence

TABLE 8 Comparisons of the cuspid to cuspid arch perimeter and sum of incisor mesiodistal diameters of unrestored, non-carious dentitions and dentitions with proximal restorations in the primary molars. The data are from SUPERVISED SAMPLE, age nine years.

MALES	No Restorations		Restorations			
	N	Mean in mm.	N	Mean in mm.	Diff.	't'
MAX. LEFT ARCH TEETH	19	22.71	59	22.85	- .15	0.36
	19	22.19	66	22.68	- .49	1.50
MAX. ANT. ARCH TEETH	19	32.07	67	32.95	- .88	1.20
	19	29.79	67	30.85	-1.06	1.90
MAX. RIGHT ARCH TEETH	19	22.62	60	22.60	.02	.05
	19	22.37	66	22.81	- .44	1.46
MAND. LEFT ARCH TEETH	19	23.21	61	23.40	- .19	.57
	19	22.72	66	23.39	- .68	2.20 ^{it}
MAND. ANT ARCH TEETH	19	22.89	67	23.56	- .77	1.83
	19	22.41	67	23.01	- .60	1.32
MAND. RIGHT ARCH TEETH	19	23.33	60	23.55	- .22	.67
	19	22.92	66	23.59	- .68	2.08 ^{it}
FEMALES						
MAX. LEFT ARCH TEETH	19	22.06	34	22.23	- .17	.46
	20	21.69	37	22.58	- .89	2.62 ^{it}
MAX. ANT. ARCH TEETH	20	31.94	38	32.05	- .12	.17
	20	30.05	38	30.24	- .20	.30
MAX. RIGHT ARCH TEETH	18	22.17	34	22.33	- .16	.42
	20	21.76	37	22.64	- .88	2.76 ^{it}
MAND. LEFT ARCH TEETH	17	22.82	33	23.46	- .64	1.14
	20	21.97	37	23.09	-1.12	2.85 ^{it}
MAND. ANT. ARCH TEETH	20	22.63	38	23.03	- .40	1.11
	20	22.26	38	22.67	- .41	1.04
MAND. RIGHT ARCH TEETH	19	22.71	33	22.95	- .24	.67
	20	22.17	37	23.19	-1.02	2.48 ^{it}

^{it} - significant at the 5% level of confidence

^{it}^{it} - significant at the 1% level of confidence

TABLE 9 Results of test to determine whether proximal restorations are the cause of larger values in "restored" groups.

SUPERVISED SAMPLE

MAXILLA		N	Mean in mm.		S.D. _m	S.D. _s
LEFT SIDE - No restorations	ARCH	13	22.01		.28	1.00
	TEETH	15		21.95	.30	1.14
ANTERIOR	ARCH	15	31.46		.56	2.17
	TEETH	15		30.01	.46	1.77
RIGHT SIDE - 1 or 2 proximals	ARCH	13	21.87		.34	1.21
	TEETH	15		21.95	.35	1.34
LEFT SIDE - 1 or 2 proximal restorations	ARCH	17	22.14		.25	1.01
	TEETH	19		22.12	.25	1.08
ANTERIOR	ARCH	19	32.86		.45	1.95
	TEETH	19		30.29	.46	2.02
RIGHT SIDE - No restorations	ARCH	17	22.09		.27	1.09
	TEETH	19		22.47	.26	1.13
MANDIBLE						
LEFT SIDE - No restorations	ARCH	8	22.84		.20	.55
	TEETH	8		22.66	.22	.64
ANTERIOR	ARCH	8	23.45		.54	1.52
	TEETH	8		22.74	.67	1.90
RIGHT SIDE - 1 or 2 proximal restorations	ARCH	8	22.86		.22	.61
	TEETH	8		22.74	.31	.88
LEFT SIDE - 1 or 2 proximal restorations	ARCH	8	22.96		.17	.47
	TEETH	8		22.63	.10	.29
ANTERIOR	ARCH	8	23.20		.46	1.31
	TEETH	8		21.59	.87	2.47
RIGHT SIDE - No restorations	ARCH	6	22.60		.29	.70
	TEETH	8		22.84	.27	.76

TABLE 10 Mesiodistal Crown Diameters of Unrestored, Non-carious Deciduous teeth. No "antimere" or "unreliable" (see Table 5) measures were used.

SUPERVISED SAMPLE

LEFT SIDE

MAXILLA

			N	MEAN (mm.)	S.D. _m	S.D. _s	C.V. %
di ₁	M		116	6.35	.037	0.41	6.5
	F		87	6.31	.039	0.37	5.9
di ₂	M		133	5.18	.030	0.36	6.9
	F		106	5.16	.035	0.36	7.0
dc	M		138	6.82	.032	0.39	5.7
	F		111	6.64	.030	0.32	4.9
dm ₁	M		103	7.02	.049	0.50	7.2
	F		79	6.83	.049	0.44	6.5
dm ₂	M		107	8.77	.042	0.45	5.1
	F		76	8.75	.054	0.47	5.4

MANDIBLE

di ₁	M		78	4.01	.039	0.35	8.7
	F		53	3.96	.047	0.34	8.7
di ₂	M		133	4.57	.033	0.39	8.4
	F		100	4.51	.035	0.35	7.8
dc	M		138	5.81	.028	0.35	6.0
	F		111	5.67	.028	0.30	5.3
dm ₁	M		85	7.65	.049	0.46	6.0
	F		62	7.49	.050	0.40	5.3
dm ₂	M		94	9.69	.046	0.45	4.7
	F		75	9.57	.052	0.46	4.8

TABLE 11 Mesiodistal Crown Diameters of Unrestored, Non-carious Deciduous Teeth. No "antimere" or "unreliable" (see Table 5) measures were used. SUPERVISED SAMPLE

RIGHT SIDE

MAXILLA			N	MEAN (mm.)	S.D. _m	S.D. _s	C.V. %
di ₁	M		113	6.37	.039	0.42	6.6
	F		93	6.34	.041	0.40	6.4
di ₂	M		131	5.19	.032	0.38	7.3
	F		103	5.13	.036	0.38	7.3
dc	M		136	6.78	.032	0.38	5.6
	F		112	6.68	.033	0.36	5.3
dm ₁	M		107	6.99	.042	0.45	6.4
	F		76	6.80	.049	0.43	6.3
dm ₂	M		107	8.82	.046	0.48	5.5
	F		81	8.75	.047	0.43	4.9
MANDIBLE							
di ₁	M		82	4.01	.039	0.36	9.0
	F		49	3.99	.044	0.31	7.8
di ₂	M		128	4.59	.035	0.40	8.6
	F		95	4.53	.037	0.37	8.2
dc	M		136	5.77	.030	0.37	6.4
	F		112	5.70	.030	0.32	5.7
dm ₁	M		83	7.78	.049	0.45	5.8
	F		63	7.54	.057	0.45	6.0
dm ₂	M		95	9.66	.050	0.49	5.1
	F		72	9.58	.050	0.43	4.5

TABLE 12 Mesiodistal Crown Diameters of Unrestored, Non-carious Permanent Teeth measured in this investigation. No "antimere" or "unreliable" (see Table 6) measures were used.

SUPERVISED SAMPLE

LEFT SIDE

MAXILLA			N	MEAN (mm.)	S.D. _m	S.D. _s	C.V. %
I ₁	M		137	8.78	.050	0.59	6.7
	F		111	8.60	.049	0.52	6.1
I ₂	M		112	6.76	.054	0.58	8.5
	F		106	6.60	.050	0.52	7.9
M ₁	M		91	10.30	.059	0.57	5.5
	F		68	10.05	.059	0.49	4.9
MANDIBLE							
I ₁	M		137	5.53	.033	0.41	7.3
	F		114	5.39	.033	0.36	6.7
I ₂	M		135	6.02	.035	0.41	6.8
	F		114	5.91	.035	0.38	6.4
M ₁	M		48	10.89	.091	0.63	5.8
	F		41	10.55	.099	0.63	6.0

TABLE 13 Mesiodistal Crown Diameters of Unrestored, Non-carious Permanent Teeth measured in this study. No "antimere" or "unreliable" (see Table 6) measures were used.

SUPERVISED SAMPLE

RIGHT SIDE

MAXILLA			N	MEAN (mm.)	S.D. _m	S.D. _s	C.V. %
I ₁	M		136	8.85	.052	0.61	6.9
	F		111	8.63	.047	0.51	5.9
I ₂	M		113	6.75	.058	0.61	9.1
	F		106	6.67	.056	0.58	8.6
M ₁	M		78	10.36	.061	0.54	5.2
	F		58	10.05	.064	0.49	4.9
MANDIBLE							
I ₁	M		136	5.51	.033	0.40	7.2
	F		115	5.37	.033	0.37	6.8
I ₂	M		133	5.99	.035	0.41	6.8
	F		114	5.87	.035	0.38	6.5
M ₁	M		47	10.86	.085	0.59	5.4
	F		43	10.48	.081	0.54	5.1

TABLE 14 Means for arch length and tooth material for all data using filled, carious and opposite side teeth. SUPERVISED SAMPLE.

SIX YEAR	MALES					FEMALES				
	N	MEAN (mm) ARCH	TEETH	SD _m	SD _s	N	MEAN (mm) ARCH	TEETH	SD _m	SD _s
MAX LEFT	139	37.22		.16	1.93	114	36.27		.17	1.83
	138		34.37	.15	1.77	114		33.95	.15	1.63
MAX RIGHT	139	36.83		.17	1.95	115	36.18		.15	1.62
	138		34.32	.16	1.85	115		33.96	.17	1.80
MAX ARCH MAX TEETH	139	74.04		.32	3.75	114	72.44		.30	3.20
	138		68.68	.30	3.57	114		67.90	.31	3.34
MAND LEFT	139	34.13		.14	1.61	113	33.25		.13	1.42
	139		32.42	.15	1.73	112		32.14	.15	1.59
MAND RIGHT	139	33.89		.15	1.74	113	33.21		.15	1.56
	139		32.36	.16	1.90	112		32.32	.16	1.68
MAND ARCH MAND TEETH	139	68.02		.27	3.15	112	66.44		.26	2.76
	139		64.78	.30	3.52	111		64.43	.31	3.22
NINE YEAR						FEMALES				
MAX LEFT	138	38.80		.20	2.30	115	37.86		.18	1.96
	138		37.78	.17	1.97	113		37.20	.16	1.73
MAX RIGHT	138	38.45		.18	2.17	115	37.71		.20	2.12
	138		37.93	.17	1.95	113		37.31	.18	1.89
MAX ARCH MAX TEETH	138	77.25		.36	4.26	115	75.56		.37	3.91
	138		75.71	.33	3.86	113		74.51	.33	3.51
MAND LEFT	138	34.70		.16	1.87	115	33.67		.20	2.17
	137		34.70	.15	1.75	112		33.97	.17	1.76
MAND RIGHT	138	34.66		.17	1.98	115	33.70		.17	1.83
	137		34.71	.16	1.89	112		34.03	.17	1.80
MAND ARCH MAND TEETH	138	69.35		.31	3.58	115	67.37		.34	3.61
	137		69.41	.30	3.47	112		68.00	.33	3.46

TABLE 15 Means for arch length and tooth material using data
computed from arches containing no missing or restored
teeth.

SUPERVISOR SAMPLE

SIX YEAR	MALES					FEMALES				
	N	MEAN (mm) ARCH TEETH	SD _m	SD _s		N	MEAN (mm) ARCH TEETH	SD _m	SD _s	
MAX LEFT	75	36.94	.21	1.78	57	36.13	.22	1.64		
	75	34.07	.19	1.67	57	33.53	.20	1.52		
MAX RIGHT	75	36.68	.20	1.70	57	35.91	.20	1.47		
	75	34.10	.20	1.73	57	33.46	.20	1.48		
MAX. ARCH	75	73.62	.39	3.34	57	72.03	.40	3.02		
MAX. TEETH	75	68.17	.39	3.37	57	66.99	.39	2.94		
MAND LEFT	75	34.09	.18	1.58	57	32.99	.18	1.39		
	75	32.17	.20	1.74	57	31.60	.18	1.35		
MAND RIGHT	75	33.96	.18	1.59	57	32.97	.19	1.40		
	75	32.25	.20	1.71	57	31.68	.19	1.42		
MAND ARCH	75	68.05	.35	3.03	57	65.95	.35	2.66		
MAND TEETH	75	64.42	.39	3.39	57	63.28	.36	2.73		
NINE YEAR	MALES				FEMALES					
MAX LEFT	36	38.78	.37	2.20	29	37.78	.38	2.02		
	36	37.32	.30	1.81	29	36.91	.32	1.74		
MAX RIGHT	36	38.36	.33	2.00	29	37.54	.37	2.01		
	36	37.41	.29	1.72	29	37.02	.30	1.60		
MAX ARCH	36	77.14	.68	4.06	29	75.32	.72	3.89		
MAX TEETH	36	74.73	.58	3.47	29	73.93	.61	3.28		
MAND LEFT	36	34.62	.26	1.53	29	33.56	.42	2.25		
	36	34.19	.24	1.45	29	33.69	.36	1.94		
MAND RIGHT	36	34.57	.28	1.70	29	33.82	.36	1.92		
	36	34.26	.24	1.43	29	33.77	.37	1.98		
MAND ARCH	36	69.19	.52	3.14	29	67.39	.73	3.94		
MAND TEETH	36	68.46	.47	2.81	29	67.44	.72	3.87		

TABLE 16

Average spacing-crowding values for maximum data using restored, carious and opposite side teeth. A plus value indicates spacing to the extent of the associated value. A negative value indicates crowding. SUPERVISED SAMPLE

SIX YEAR	MALES				FEMALES			
	N	Mean in mm.	S.D. _m	S.D. _s	N	Mean in mm.	S.D. _m	S.D. _s
MAX LEFT	138	2.84	0.14	1.63	114	2.32	0.17	1.80
MAX RIGHT	138	2.50	0.13	1.53	115	2.22	0.15	1.62
MAXILLA	138	5.34	0.26	3.00	114	4.54	0.29	3.11
MAND LEFT	139	1.71	0.13	1.51	112	1.13	0.15	1.54
MAND RIGHT	139	1.53	0.13	1.49	112	0.91	0.15	1.62
MANDIBLE	139	3.24	0.24	2.80	111	2.05	0.28	2.92
NINE YEAR	MALES				FEMALES			
MAX LEFT	138	1.02	0.17	1.99	113	0.70	0.17	1.79
MAX RIGHT	138	0.53	0.16	1.89	113	0.44	0.18	1.89
MAXILLA	138	1.55	0.31	3.64	113	1.14	0.32	3.41
MAND LEFT	137	0.02	0.16	1.84	112	-0.25	0.20	2.07
MAND RIGHT	137	-0.04	0.16	1.88	112	-0.27	0.16	1.72
MANDIBLE	137	-0.02	0.30	3.46	112	-0.52	0.32	3.33

TABLE 17

Average spacing-crowding values for data computed from arches containing no missing or restored teeth. A plus value indicates spacing and a negative value indicates crowding.

SUP REVISED SAMPLE

SIX YEAR	MALES				FEMALES			
	N	Mean in mm.	S.D. _m	S.D. _s	N	Mean in mm.	S.D. _m	S.D. _s
MAX LEFT	75	2.88	0.18	1.55	57	2.60	0.21	1.60
MAX RIGHT	75	2.58	0.16	1.35	57	2.44	0.19	1.42
MAXILLA	75	5.45	0.32	2.74	57	5.05	0.38	2.88
MAND LEFT	75	1.92	0.16	1.36	57	1.88	0.18	1.37
MAND RIGHT	75	1.71	0.14	1.18	57	1.29	0.19	1.43
MANDIBLE	75	3.63	0.27	2.36	57	2.67	0.35	2.67
NINE YEAR	MALES				FEMALES			
	N	Mean in mm.	S.D. _m	S.D. _s	N	Mean in mm.	S.D. _m	S.D. _s
MAX LEFT	36	1.46	0.30	1.82	29	0.87	0.34	1.84
MAX RIGHT	36	0.95	0.20	1.22	29	0.51	0.33	1.76
MAXILLA	36	2.41	0.48	2.86	29	1.38	0.64	3.44
MAND LEFT	36	0.43	0.24	1.43	29	-0.11	0.35	1.89
MAND RIGHT	36	0.30	0.25	1.48	29	0.05	0.29	1.56
MANDIBLE	36	0.73	0.47	2.82	29	-0.06	0.59	3.15

TABLE 18 - Means for arch length and tooth material in three segments per arch, using maximum data.

CONTROL SAMPLE

SIX YEAR		MALES				FEMALES			
	N	MEAN (mm) ARCH TEETH	SD _m	SD _s		MEAN (mm) ARCH TEETH	SD _m	SD _s	
MAX LEFT	164 156	23.48 22.82	.11 .08	1.42 1.02	129 126	23.00 22.39	.09 .08	1.03 .94	
MAX ANTERIOR	164 146	26.69 23.45	.17 .13	2.14 1.52	129 115	26.19 23.07	.17 .15	1.97 1.56	
MAX RIGHT	163 156	23.41 22.90	.09 .09	1.15 1.10	127 125	23.03 22.48	.11 .09	1.27 .99	
MAND LEFT	164 147	23.83 23.39	.13 .08	1.67 .97	128 115	23.24 23.13	.16 .10	1.78 1.03	
MAND ANTERIOR	164 148	19.92 18.39	.16 .16	2.01 1.90	129 116	19.77 18.67	.17 .19	1.90 2.03	
MAND RIGHT	159 144	24.08 23.42	.09 .08	1.18 .96	126 114	23.45 23.17	.12 .09	1.31 .99	
NINE YEAR		MALES				FEMALES			
MAX LEFT	128 116	22.71 22.54	.12 .11	1.34 1.15	102 84	21.97 22.32	.15 .11	1.50 1.04	
MAX ANTERIOR	132 121	31.89 30.94	.21 .16	2.40 1.80	104 102	31.02 30.28	.18 .20	1.87 1.97	
MAX RIGHT	129 113	22.62 22.59	.14 .12	1.54 1.24	101 84	21.97 22.37	.17 .11	1.68 1.01	
MAND LEFT	125 102	23.19 23.36	.16 .12	1.81 1.23	101 73	22.90 22.98	.16 .13	1.64 1.11	
MAND ANTERIOR	132 129	23.03 22.91	.14 .11	1.55 1.22	104 104	22.31 22.47	.12 .13	1.23 1.36	
MAND RIGHT	122 101	23.37 23.48	.19 .11	2.04 1.14	97 71	22.75 23.06	.17 .14	1.65 1.14	

TABLE 19 - Means for arch length and tooth material in three segments per arch using maximum data.

						SUPERVISED SAMPLE				
SIX YEAR	N	MALES		SD _m	SD _s	N	FEMALES		SD _m	SD _s
		MEAN ARCH	(mm) TEETH				MEAN ARCH	(mm) TEETH		
MAX LEFT	139	23.59		.09	1.12	114	22.91		.13	1.34
	139		22.74	.10	1.16	114		22.36	.10	1.07
MAX ANTERIOR	139	26.90		.20	2.35	115	26.57		.20	2.13
	138		23.24	.14	1.67	115		23.17	.16	1.72
MAX RIGHT	139	23.55		.09	1.11	114	22.99		.10	1.05
	139		22.70	.10	1.13	115		22.38	.11	1.17
MAND LEFT	139	23.76		.27	3.12	113	23.33		.11	1.14
	139		23.33	.10	1.13	112		22.91	.09	.98
MAND ANTERIOR	139	20.04		.15	1.79	115	19.86		.17	1.86
	139		18.10	.19	2.23	115		18.55	.19	2.01
MAND RIGHT	136	24.01		.10	1.14	113	23.30		.11	1.16
	139		23.35	.10	1.16	112		23.03	.10	1.06
NINE YEAR	MALES					FEMALES				
MAX LEFT	123	22.66		.15	1.65	97	22.09		.13	1.32
	138		22.52	.10	1.20	113		22.16	.11	1.15
MAX ANTERIOR	137	32.69		.23	2.67	115	32.15		.22	2.38
	139		30.57	.20	2.33	115		30.22	.21	2.26
MAX RIGHT	125	22.53		.15	1.64	96	22.15		.14	1.36
	138		22.63	.09	1.10	113		22.18	.11	1.16
MAND LEFT	124	23.21		.13	1.41	95	22.78		.19	1.82
	137		23.22	.10	1.19	112		22.72	.13	1.35
MAND ANTERIOR	139	23.42		.16	1.87	115	22.78		.14	1.49
	139		22.83	.16	1.86	115		22.49	.14	1.44
MAND RIGHT	122	23.28		.12	1.30	97	22.65		.14	1.39
	137		23.39	.10	1.20	112		22.82	.13	1.39

TABLE 20

Average spacing-crowding values in three segments
per arch using maximum data.

					CONTROL SAMPLE			
SIX YEAR					FEMALES			
	N	Mean in mm.	S.D. m	S.D. s	N	Mean in mm.	S.D. m	S.D. s
MAX LEFT	156	0.73	0.09	1.09	126	0.61	0.05	0.58
MAX ANT	146	3.31	0.18	2.15	115	3.04	0.17	1.87
MAX RIGHT	155	0.61	0.07	0.92	124	0.57	0.08	0.86
MAND LEFT	147	0.54	0.12	1.39	115	0.19	0.16	1.71
MAND ANT	148	1.46	0.17	2.11	116	1.02	0.20	2.13
MAND RIGHT	144	0.78	0.05	0.65	114	0.39	0.11	1.12
NINE YEAR					FEMALES			
MAX LEFT	115	0.29	0.07	0.75	84	-0.04	0.08	0.71
MAX ANT	121	1.07	0.20	2.21	102	0.81	0.19	1.91
MAX RIGHT	113	0.15	0.09	0.91	83	-0.02	0.07	0.67
MAND LEFT	102	0.21	0.12	1.20	73	0.12	0.18	1.54
MAND ANT	129	0.16	0.13	1.42	104	-0.16	0.12	1.19
MAND RIGHT	99	0.29	0.15	1.51	70	-0.03	0.12	0.96

TABLE 21

Average spacing-crowding values in three segments per arch
using maximum data.

SUPERVISED 3.5 YEAR

<u>SIX YEAR</u>		<u>MALES</u>			<u>FEMALES</u>			
	N	Mean in mm.	S.D. m	S.D. s	N	Mean in mm.	S.D. m	S.D. s
MAX LEFT	139	0.85	0.06	0.72	114	0.56	0.11	1.15
MAX ANT	138	3.63	0.19	2.27	115	3.39	0.20	2.10
MAX RIGHT	139	0.86	0.05	0.64	114	0.63	0.08	0.85
MAND LEFT	137	0.77	0.07	0.82	112	0.46	0.08	0.84
MAND ANT	139	1.94	0.19	2.24	115	1.31	0.19	2.00
MAND RIGHT	136	0.66	0.06	0.72	112	0.31	0.09	0.92

<u>NINE YEAR</u>		<u>MALES</u>			<u>FEMALES</u>			
MAX LEFT	122	0.27	0.12	1.29	96	0.03	0.11	1.11
MAX ANT	137	2.23	0.17	1.99	115	1.93	0.16	1.74
MAX RIGHT	124	0.01	0.11	1.25	95	0.05	0.11	1.05
MAND LEFT	123	0.14	0.10	1.16	93	0.04	0.18	1.70
MAND ANT	139	0.60	0.15	1.81	115	0.30	0.10	1.08
MAND RIGHT	121	0.05	0.10	1.06	96	-0.17	0.14	1.35

TABLE 22

Summary of the mean values for the various arch
relationship measures made for the SUPERVISED SAMPLE
AT AGE SIX YEARS

		sex	N	Mean (mm.)		SD _m	SD _s
OVERJET I		M	122	3.18		0.15	1.68
		F	98	3.09		0.16	1.55
OVERJET II		M	119	0.99		0.17	1.81
		F	96	1.08		0.18	1.74
MOLAR RELATION- SHIP	LEFT	M	130	0.27		0.14	1.58
		F	107	-0.03		0.14	1.40
	RIGHT	M	134	0.36		0.13	1.52
		F	106	0.09		0.13	1.30
CUSPID RELATION- SHIP	LEFT	M	138	1.70		0.15	1.74
		F	113	1.43		0.16	1.67
	RIGHT	M	138	1.89		0.15	1.72
		F	113	1.68		0.13	1.36
MIDLINE		M	111	0.19		0.07	0.76
		F	91	0.22		0.10	0.97
OVERBITE		M	118	1.61		0.13	1.46
		F	98	1.20		0.16	1.63
ARCH LENGTH	MAX	M	130	28.20		0.17	1.93
		F	106	27.96		0.18	1.88
	MAND	M	132	25.65		0.14	1.65
		F	107	25.19		0.13	1.31
ARCH WIDTH MAXILLA	MOLAR	M	138	41.24		0.20	2.29
		F	114	40.07		0.20	2.12
	CUSPID	M	138	29.46		0.17	2.03
		F	114	28.75		0.19	2.07
ARCH WIDTH MANDIBLE	MOLAR	M	138	37.35		0.18	2.08
		F	110	36.28		0.19	2.04
	CUSPID	M	138	23.67		0.15	1.80
		F	114	23.25		0.17	1.76
PALATE DEPTH		M	138	15.15		0.12	1.39
		F	112	14.96		0.13	1.38

TABLE 23

Summary of mean values for the various arch relationship measures made for the SUPERVISED SAMPLE AT AGE NINE YEARS.

		sex	N	Mean (mm.)		SD _m	SD _s
OVERJET	I	M	138	4.20		0.14	1.64
		F	114		4.07	0.13	1.34
OVERJET	II	M	133	1.18		0.13	1.52
		F	108		1.34	0.15	1.59
MOLAR RELATION- SHIP	LEFT	M	139	1.12		0.17	1.99
		F	113		0.97	0.15	1.56
	RIGHT	M	138	1.61		0.16	1.93
		F	113		1.10	0.14	1.46
CUSPID RELATION- SHIP	LEFT	M	108	1.02		0.17	1.76
		F	70		1.12	0.19	1.57
	RIGHT	M	108	1.17		0.18	1.84
		F	76		1.01	0.20	1.76
MIDLINE		M	134	0.11		0.08	0.95
		F	114		0.08	0.09	0.94
OVERBITE		M	138	3.14		0.13	1.50
		F	114		2.81	0.14	1.51
ARCH LENGTH	MAXILLA	M	138	30.09		0.23	2.64
		F	114		29.56	0.17	1.82
	MANDIBLE	M	139	26.22		0.15	1.77
		F	115		25.57	0.14	1.53
ARCH WIDTH MAXILLA	MOLAR	M	139	42.77		0.20	2.37
		F	115		41.64	0.22	2.35
	CUSPID	M	113	32.14		0.18	1.95
		F	85		31.51	0.20	1.85
ARCH WIDTH MANDIBLE	MOLAR	M	139	38.18		0.20	2.39
		F	115		37.09	0.22	2.31
	CUSPID	M	115	26.20		0.16	1.74
		F	74		25.25	0.19	1.64
PALATE DEPTH		M	135	16.47		0.16	1.84
		F	111		16.19	0.14	1.47

TABLE 24 Summary of 't' tests of the average values for tooth size between the Control and SUPERVISED SAMPLES
The average values for the various mesiodistal tooth diameters are from the samples at age SIX.

LEFT SIDE								RIGHT SIDE					
MAXILLA		N	Mean	N	Mean	Diff.	't'	N	Mean	N	Mean	Diff.	't'
di ₁	M	136	6.43	116	6.35	.07	1.43	134	6.46	113	6.37	.09	1.72
	F	102	6.30	87	6.31	-.01	.20	107	6.32	93	6.34	-.02	.40
di ₂	M	157	5.17	133	5.18	-.01	.29	154	5.18	131	5.19	-.02	.41
	F	124	5.17	106	5.16	.01	.24	122	5.14	103	5.13	.00	.06
dc	M	162	6.81	138	6.82	-.01	.20	166	6.80	136	6.78	.02	.46
	F	129	6.66	111	6.64	.01	.31	129	6.60	112	6.68	-.07	1.56
dm ₁	M	133	7.11	103	7.02	.09	1.50	130	7.08	107	6.99	.10	1.75
	F	107	6.89	79	6.83	.06	.98	105	6.93	76	6.80	.13	1.99
dm ₂	M	134	8.94	107	8.77	.17	2.84##	135	9.00	107	8.82	.18	2.72##
	F	112	8.79	76	8.75	.04	.64	105	8.91	81	8.75	.16	2.56#
LEFT SIDE								RIGHT SIDE					
MANDIBLE													
di ₁	M	93	4.00	78	4.01	-.01	.29	88	4.05	82	4.01	.04	.76
	F	52	3.95	53	3.96	-.02	.24	51	3.99	49	3.99	.00	.06
di ₂	M	153	4.58	133	4.57	.01	.24	149	4.57	128	4.59	-.02	.51
	F	114	4.56	100	4.51	.05	.93	110	4.57	95	4.53	.04	.77
dc	M	165	5.75	138	5.81	-.06	1.55	161	5.77	136	5.77	.00	.07
	F	127	5.73	111	5.67	.06	1.48	129	5.71	112	5.70	.01	.30
dm ₁	M	110	7.77	85	7.65	.12	1.81	113	7.82	83	7.78	.05	.70
	F	84	7.60	62	7.49	.10	1.49	91	7.69	63	7.54	.15	2.05#
dm ₂	M	128	9.90	94	9.69	.21	3.51##	129	9.84	95	9.66	.18	2.90##
	F	100	9.73	75	9.57	.16	2.35#	102	9.73	72	9.58	.15	2.22#

- significant at 1% level of confidence

- significant at 5% level of confidence

TABLE 25 Summary of 't' tests of the average values for tooth size between the Control and SUPERVISED SAMPLES. The average values for the various mesiodistal tooth diameters are from the samples at NINE YEARS OF AGE.

LEFT SIDE								RIGHT SIDE					
Control				Serial				Control			Serial		
MAXILLA		N	Mean	N	Mean	Diff.	't'	N	Mean	N	Mean	Diff.	't'
I ₁	M	127	8.75	137	8.78	-.03	.43	128	8.84	136	8.85	-.00	.06
	F	104	8.57	111	8.60	-.03	.47	104	8.61	111	8.63	-.03	.38
I ₂	M	109	6.74	112	6.76	-.02	.30	115	6.79	113	6.75	.04	.52
	F	95	6.57	106	6.60	-.04	.46	98	6.61	106	6.67	-.07	.81

LEFT SIDE								RIGHT SIDE					
Control				Serial				Control			Serial		
MANDIBLE		N	Mean	N	Mean	Diff.	't'	N	Mean	N	Mean	Diff.	't'
I ₁	M	123	5.56	137	5.53	.04	.41	125	5.47	136	5.51	-.03	.73
	F	106	5.36	114	5.39	-.03	.54	106	5.35	115	5.37	-.01	.26
I ₂	M	124	6.00	135	6.02	-.02	.33	127	6.00	133	5.99	.01	1.22
	F	106	5.91	114	5.91	-.00	.03	104	5.81	114	5.87	-.06	1.14

TABLE 26 Summary of 't' tests on arch length and tooth material for the Control sample versus the SUPERVISED SAMPLE.

SIX YEARS OF AGE						
	Control		Serial			
	N	Mean	N	Mean	Diff.	't'
<u>MALES</u>						
MAXILLARY ARCH	164	73.57	139	74.04	-.48	1.14
MAXILLARY TEETH	143	69.11	138	68.68	.42	1.07
MANDIBULAR ARCH	161	67.83	139	68.02	-.19	.49
MANDIBULAR TEETH	135	65.23	139	64.78	.44	1.13
<u>FEMALES</u>						
MAXILLARY ARCH	127	72.26	114	72.44	-.18	.43
MAXILLARY TEETH	113	67.94	114	67.90	.04	.08
MANDIBULAR ARCH	126	66.43	112	66.44	-.02	.04
MANDIBULAR TEETH	107	64.87	111	64.43	.44	1.02
NINE YEARS OF AGE						
<u>MALES</u>						
MAXILLARY ARCH	132	76.93	138	77.25	-.33	.68
MAXILLARY TEETH	108	75.92	138	75.71	.21	.44
MANDIBULAR ARCH	131	69.15	138	69.35	-.20	.43
MANDIBULAR TEETH	99	69.98	137	69.41	.56	1.28
<u>FEMALES</u>						
MAXILLARY ARCH	105	74.75	115	75.56	-.82	1.58
MAXILLARY TEETH	84	74.91	113	74.51	.40	.80
MANDIBULAR ARCH	105	67.66	115	67.37	.29	.58
MANDIBULAR TEETH	71	68.55	112	68.00	.55	1.09

TABLE 27 Summary of 't' tests on Spacing-crowding for the
Control sample versus the SUPERVISED SAMPLE.

	Control		Serial			
	N	Mean	N	Mean	Diff.	't'
SIX YEARS OF AGE						
MALES						
MAXILLA	142	4.76	138	5.34	-.58	1.63
MANDIBLE	135	2.80	139	3.24	-.44	1.27
FEMALES						
MAXILLA	112	4.29	114	4.54	-.25	.66
MANDIBLE	107	1.51	111	2.05	-.54	1.20
NINE YEARS OF AGE						
MALES						
MAXILLA	108	1.39	138	1.55	-.16	.38
MANDIBLE	99	.24	137	-.02	.27	.63
FEMALES						
MAXILLA	84	.56	113	1.14	-.58	1.32
MANDIBLE	71	-.12	112	-.52	.40	.86

TABLE 28 Summary of 't' tests on Arch length and Tooth material in three segments per arch for the Control sample versus the SUPERVISED SAMPLE.

SIX YEARS		MALES						FEMALES					
OF AGE		Control		Serial		Diff.	't'	Control		Serial		Diff.	't'
		N	Mean	N	Mean			N	Mean	N	Mean		
MAX	A	164	23.48	139	23.59	-.11	.77	129	23.00	114	22.91	.08	.53
LEFT	T	156	22.82	139	22.74	.08	.62	126	22.39	114	22.36	.04	.28
MAX	A	164	26.69	139	26.90	-.21	.80	129	26.19	115	26.57	-.38	1.45
ANT	T	146	23.45	138	23.24	.20	1.08	115	23.07	115	23.17	-.10	.48
MAX	A	163	23.41	139	23.55	-.14	1.06	127	23.03	114	22.99	.04	.23
RT.	T	156	22.90	139	22.70	.21	1.58	125	22.48	115	22.38	.11	.77
MAND	A	164	23.83	139	23.76	.07	.26	128	23.24	113	23.33	-.09	.47
LEFT	T	147	23.39	139	23.33	.06	.47	115	23.13	112	22.91	.23	1.71
MAND	A	164	19.92	139	20.04	-.12	.54	129	19.77	115	19.86	-.09	.38
ANT	T	148	18.39	139	18.10	.29	1.17	116	18.67	115	18.55	.12	.46
MAND	A	159	24.08	136	24.01	.07	.54	126	23.45	113	23.30	.15	.94
RT.	T	144	23.42	139	23.35	.08	.60	114	23.17	112	23.03	.14	1.01
NINE YEARS													
OF AGE													
MAX	A	128	22.71	123	22.66	.06	.31	102	21.97	97	22.09	-.13	.62
LEFT	T	116	22.54	138	22.52	.02	.13	84	22.32	113	22.16	.16	1.00
MAX	A	132	31.89	137	32.69	-.81	2.60	104	31.02	115	32.15	-1.13	3.88##
ANT	T	121	30.94	139	30.57	.37	1.39	102	30.28	115	30.22	.07	.23
MAX	A	129	22.62	125	22.53	.09	.45	101	21.97	96	22.15	-.18	.84
RT	T	113	22.59	138	22.63	-.03	.22	84	22.37	113	22.18	.19	1.22
MAND	A	125	23.19	124	23.21	-.01	.07	101	22.90	95	22.78	.12	.47
LEFT	T	102	23.36	137	23.22	.14	.86	73	22.98	112	22.72	.25	1.34
MAND	A	132	23.03	139	23.42	-.39	1.87	104	22.31	115	22.78	-.47	2.55##
ANT	T	129	22.91	139	22.83	.08	.42	104	22.47	115	22.49	-.02	.11
MAND	A	122	23.37	122	23.28	.09	.39	97	22.75	97	22.65	.10	.46
RT	T	101	23.48	137	23.39	.09	.60	71	23.06	112	22.82	.23	1.18

Significant at 1% level of confidence

Significant at 5% level of confidence

A - Arch

T - Teeth

TABLE 29 Summary of 't' tests on Spacing-crowding material in three segments per arch for the Control sample versus the SUPERVISED sample.

SIX YEARS OF AGE	MALES						FEMALES					
	Control		Serial		Diff.	't'	Control		Serial		Diff.	't'
	N	Mean	N	Mean			N	Mean	N	Mean		
MAX. LEFT	156	.73	139	.85	-.12	1.10	126	.61	114	.56	.06	.47
MAX. ANT.	146	3.31	138	3.63	-.32	1.23	115	3.04	115	3.39	-.35	1.35
MAX. RT.	155	.61	139	.86	-.25	2.70 ^{##}	124	.57	114	.63	6.06	.54
MAND. LEFT	147	.54	137	.77	-.23	1.68	115	.19	112	.46	-.26	1.47
MAND. ANT.	148	1.46	139	1.94	-.48	1.87	116	1.02	115	1.31	-.29	1.05
MAND. RT.	144	.78	136	.66	.12	1.43	114	.39	112	.31	.08	.60
NINE YEARS OF AGE												
MAX. LEFT	115	.29	122	.27	.02	.13	84	-.04	96	.03	-.07	.49
MAX. ANT.	121	1.07	137	2.23	-1.15	4.40 ^{##}	102	.81	115	1.93	-1.12	4.50 ^{##}
MAX. RT.	113	.15	124	.01	.15	1.08	83	-.02	95	.05	-.07	.52
MAND. LEFT	102	.21	123	.14	.07	.46	73	.12	93	.04	.08	.33
MAND. ANT.	129	.16	139	.60	-.43	2.17 [#]	104	-.16	115	.30	-.45	2.96 ^{##}
MAND. RT.	99	.29	121	.05	.24	1.39	70	-.03	96	-.17	.15	.78

^{##} - Significant at 1% level of confidence

[#] - Significant at 5% level of confidence

TABLE 30 Summary of 't' tests on arch relationship and dimension measures for the Control sample versus the SUPERVISED SAMPLE at SIX YEARS OF AGE.

	sex	CONTROL		SERIAL		Diff.	't'
		N	Mean	N	Mean		
OVERJET I	M	131	2.99	122	3.18	-.19	1.05
	F	106	2.93	98	3.09	-.16	.77
OVERJET II	M	130	.42	119	.99	-.57	3.04 ^{##}
	F	106	.70	96	1.08	-.38	1.67
MOLAR RELATIONSHIP	M	158	-.01	130	.27	-.28	1.55
	F	123	-.02	107	-.03	.01	.06
	M	156	.38	134	.36	.03	.14
	F	125	.16	106	.09	.07	.43
CUSPID RELATIONSHIP	M	165	1.24	138	1.70	-.46	2.47 ^{##}
	F	130	1.17	113	1.43	-.27	1.42
	M	167	1.58	138	1.89	-.32	1.72
	F	130	1.39	113	1.68	-.30	1.75
MIDLINE	M	139	.01	111	.19	-.18	1.97 ^{##}
	F	112	.09	91	.22	-.13	.98
OVERBITE	M	131	1.62	118	1.61	.01	.07
	F	103	1.34	98	1.20	.14	.68
ARCH MAXILLARY LENGTH	M	150	28.37	130	28.20	.17	.69
	F	116	27.84	106	27.96	-.12	.52
MANDIBULAR MOLAR MAX. CUSPID	M	151	25.84	132	25.65	.20	.94
	F	123	25.26	107	25.19	.07	.35
	M	166	41.17	138	41.24	-.07	.30
	F	127	40.08	114	40.07	.02	.07
	M	166	29.52	138	29.46	.06	.25
	F	130	28.87	114	28.75	.13	.51
	M	163	37.35	138	37.35	.00	.01
	F	127	36.35	110	36.28	.06	.22
ARCH WIDTH MAND. CUSPID	M	165	23.69	138	23.67	.02	.08
	F	129	23.37	114	23.25	.12	.51
PALATE DEPTH	M	160	15.67	138	15.15	.51	2.64 ^{##}
	F	124	14.99	112	14.96	.03	.16

- Significant at 1% level of confidence

- Significant at 5% level of confidence

TABLE 31 Summary of 't' tests on arch relationship and arch dimension measures for the Control sample versus the SUPERVISED SAMPLE AT NINE YEARS OF AGE.

	sex	CONTROL		SERIAL		Diff.	't'
		N	Mean	N	Mean		
OVERJET I	M	134	4.13	138	4.20	-.07	.34
	F	107	3.72	114	4.07	-.36	1.90
OVERJET II	M	134	0.95	133	1.18	-.23	1.21
	F	108	1.18	108	1.34	-.17	.80
MOLAR RELATIONSHIP LEFT	M	135	1.09	139	1.12	-.03	.12
	F	106	.92	113	.97	-.05	.24
RIGHT	M	135	1.65	138	1.61	.04	.19
	F	106	1.20	113	1.10	.10	.49
CUSPID RELATIONSHIP LEFT	M	123	1.11	108	1.02	.09	.42
	F	92	.70	70	1.12	-.42	1.75
RIGHT	M	121	1.27	108	1.17	.10	.42
	F	94	.89	76	1.01	-.12	.47
MIDLINE	M	134	.22	134	.11	.11	.93
	F	106	.28	114	.08	.20	1.44
OVERBITE	M	134	3.26	138	3.14	.12	.71
	F	107	2.63	114	2.81	-.18	.86
ARCH LENGTH MAXILLARY	M	135	30.24	138	30.09	.15	.51
	F	108	29.55	114	29.56	-.01	.05
	M	135	26.36	139	26.22	.14	.58
	F	108	25.72	115	25.57	.15	.65
MANDIBULAR	M	137	42.73	139	42.77	-.03	.12
	F	108	41.38	115	41.64	-.27	.80
	M	124	32.11	113	32.14	-.03	.12
	F	93	31.20	85	31.51	-.31	1.16
ARCH WIDTH MAND. MOLAR	M	135	38.02	139	38.18	-.17	.60
	F	108	37.14	115	37.09	.06	.19
	M	118	26.31	115	26.20	.12	.47
	F	90	25.56	74	25.25	.31	1.07
PALATE DEPTH	M	135	17.06	135	16.47	.59	2.60 ^{##}
	F	105	16.37	111	16.19	.18	.79

- Significant at 1% level of confidence

TABLE 32 Summary of arch length and tooth material values for not-treated, treated non-extraction and treated extraction, in the SUPERVISED SAMPLE AT NINE YEARS OF AGE.

NOT-TREATED	N	MALES			N	FEMALES		
		Mean	SD _m	SD _s		Mean	SD _m	SD _s
MAX. ARCH TEETH	45	77.72	.60	4.01	26	76.48	.60	3.06
	45	75.26	.52	3.50	26	74.01	.55	2.83
MAND. ARCH TEETH	45	69.48	.48	3.23	26	68.34	.50	2.56
	45	68.56	.47	3.16	26	67.15	.49	2.48
TREATED NON-EXTRACTION								
MAX. ARCH TEETH	70	77.85	.46	3.84	69	75.73	.42	3.47
	70	75.26	.46	3.85	68	73.97	.40	3.32
MAND. ARCH TEETH	70	70.07	.38	3.17	69	67.83	.41	3.41
	70	69.30	.40	3.37	67	67.84	.43	3.51
TREATED EXTRACTION PLANNED								
MAX. ARCH TEETH	15	73.81	1.56	6.05	14	72.46	1.52	5.69
	15	78.34	1.18	4.57	13	76.98	.89	3.20
MAND. ARCH TEETH	15	65.67	1.17	4.52	14	63.85	1.13	4.24
	14	71.97	1.10	4.10	13	69.29	1.21	4.35

TABLE 33 Summary of spacing-crowding values for not-treated, treated non-extraction and treated extraction, in the SUPERVISED SAMPLE AT NINE YEARS OF AGE.

MALES					FEMALES			
NOT TREATED	N	Mean	SD _m	SD _s	N	Mean	SD _m	SD _s
MAXILLA	45	2.46	0.35	2.33	26	2.47	.49	2.49
MANDIBLE	45	.92	.40	2.68	26	1.19	.40	2.01
TREATED NON-EXTRACTION								
MAXILLA	70	2.59	.32	2.67	68	1.76	.34	2.82
MANDIBLE	70	0.76	.26	2.17	67	0.10	.34	2.76
TREATED -EXTRACTION								
MAXILLA	15	-4.53	1.16	4.48	13	-3.94	1.05	3.77
MANDIBLE	14	-6.18	1.31	4.90	13	-5.19	.78	2.81

TABLE 34 Summary of arch length and tooth material values in three segments per arch for Not-treated, Treated non-extraction and treated with extraction groups, in the SUPERVISOR SAMPLE AT NINE YEARS OF AGE.

M.ALES					FEMALES				
		N	Mean Arch Teeth	SD _m	SD _s	N	Mean Arch Teeth	SD _m	SD _s
NOT TREATED									
M.A.	LEFT	43	22.71	.18	1.16	24	22.37	.20	1.00
		45	22.45	.15	1.03	26	21.93	.19	.97
	ANT.	45	32.68	.35	2.37	26	32.10	.38	1.91
		45	30.35	.36	2.42	26	30.05	.24	1.23
	RIGHT	43	22.54	.18	1.20	25	22.35	.24	1.20
		45	22.46	.14	.92	26	22.04	.22	1.12
MAND.	LEFT	43	23.37	.15	.99	25	22.83	.23	1.17
		45	23.11	.14	.91	26	22.31	.21	1.06
	ANT.	45	22.89	.29	1.97	26	22.44	.21	1.05
		45	22.30	.31	2.07	26	22.20	.19	.97
	RIGHT	43	23.34	.16	1.08	25	23.08	.21	1.06
		45	23.15	.15	.98	26	22.64	.22	1.11
TREATED NON-EXTRACTION									
MAX.	LEFT	69	22.85	.21	1.74	62	22.12	.15	1.19
		70	22.37	.15	1.22	68	22.06	.12	1.01
	ANT.	70	32.36	.32	2.63	69	31.78	.30	2.46
		70	30.29	.28	2.30	69	29.91	.30	2.52
	RIGHT	69	22.63	.22	1.83	60	22.21	.16	1.20
		70	22.60	.14	1.16	68	22.09	.13	1.03
MAND.	LEFT	67	23.38	.14	1.15	59	22.94	.26	2.00
		70	23.10	.15	1.28	67	22.79	.17	1.36
	ANT.	70	23.46	.20	1.69	69	22.81	.18	1.52
		70	22.85	.20	1.66	69	22.33	.19	1.57
	RIGHT	65	23.46	.16	1.26	62	22.57	.18	1.44
		70	23.35	.15	1.23	67	22.79	.17	1.41
TREATED EXTRACTION									
MAX.	LEFT	4	19.65	1.45	2.91	7	21.03	1.07	2.82
		15	23.31	.37	1.43	13	22.95	.44	1.58
	ANT.	14	35.39	.74	2.78	14	33.04	.52	1.96
		16	31.96	.53	2.14	14	31.06	.45	1.69
	RIGHT	6	20.98	1.00	2.44	7	21.04	.97	2.56
		15	23.08	.34	1.33	13	22.75	.42	1.53
MAND.	LEFT	8	21.56	1.10	3.11	8	21.38	.56	1.57
		14	24.05	.40	1.49	13	22.85	.49	1.77
	ANT.	16	24.44	.53	2.11	14	23.26	.35	1.33
		16	23.73	.44	1.74	14	23.31	.34	1.28
	RIGHT	7	21.56	.76	2.01	7	21.67	.54	1.43
		14	24.24	.40	1.50	13	23.01	.48	1.73

TABLE 35 Summary of spacing-crowding values in three segments per arch for Not-treated, Treated non-extraction and Treated with extraction groups, in the SUPERVISED SAMPLE AT NINE YEARS OF AGE.

		MALES				FEMALES			
		N	Mean	SD _m	SD _s	N	Mean	SD _m	SD _s
NOT TREATED									
MAX.	LEFT	43	.30	.08	.50	24	.40	.12	.58
	ANT.	45	2.33	.21	1.40	26	2.05	.37	1.91
	RIGHT	43	.12	.10	.65	25	.29	.14	.71
MAND.	LEFT	43	.33	.13	.85	25	.51	.17	.85
	ANT.	45	.59	.28	1.86	26	.24	.20	1.02
	RIGHT	43	.24	.14	.94	25	.43	.18	.92
TREATED NON-EXTRACTION									
MAX.	LEFT	69	.50	.16	1.33	62	.14	.11	.83
	ANT.	70	2.07	.28	2.37	69	1.87	.22	1.84
	RIGHT	69	.05	.16	1.36	60	.17	.12	.94
MAND.	LEFT	67	.29	.08	.66	58	.18	.22	1.71
	ANT.	70	.61	.23	1.95	69	.48	.12	1.03
	RIGHT	65	.12	.11	.88	61	-.18	.16	1.26
TREATED - EXTRACTION PLANNED									
MAX.	LEFT	3	-3.80	1.29	2.23	6	-1.97	.99	2.42
	ANT.	14	3.18	.40	1.49	14	1.98	.36	1.36
	RIGHT	5	-2.18	1.04	2.32	6	-1.57	.65	1.58
MAND.	LEFT	7	-1.53	1.13	2.98	7	-2.51	.64	1.70
	ANT.	16	.71	.39	1.55	14	-.04	.14	.50
	RIGHT	6	-1.78	.74	1.82	7	-1.86	.67	1.76

TABLE 36 Summary of arch length and tooth material values in three segments per arch for Not-treated, Treated non-extraction and Treated with extraction groups, in the NINE YEAR SUPERVISED SAMPLE PROJECTED BACK TO SIX YEARS,

MALES					FEMALES				
		N	Mean Arch Teeth	SD _m	SD _s	N	Mean Arch Teeth	SD _m	SD _s
NOT TREATED									
MAX.	LEFT	45	23.52	.15	1.03	26	22.93	.18	.89
		45	22.46	.15	.99	26	21.93	.18	.91
	ANT.	45	27.37	.37	2.51	26	27.24	.48	2.43
		44	22.94	.22	1.42	26	22.91	.32	1.61
	RIGHT	45	23.38	.16	1.04	26	22.96	.17	.88
		45	22.46	.15	1.01	26	21.96	.19	.95
MAND.	LEFT	45	24.15	.15	1.03	26	23.37	.19	.99
		45	23.11	.14	.96	26	22.56	.17	.85
	ANT.	45	20.05	.30	1.98	26	20.27	.36	1.84
		45	17.78	.29	1.96	26	18.37	.44	2.22
	RIGHT	45	24.03	.14	.92	26	23.36	.16	.82
		45	23.11	.15	.99	26	22.69	.19	.97
TREATED NON-EXTRACTION									
MAX.	LEFT	70	23.62	.13	1.04	68	22.81	.18	1.50
		70	22.71	.14	1.17	68	22.34	.13	1.06
	ANT.	70	26.97	.24	1.99	69	26.61	.24	1.96
		70	23.22	.21	1.75	69	23.11	.21	1.77
	RIGHT	70	23.60	.13	1.12	68	22.96	.11	.95
		70	22.65	.14	1.13	69	22.37	.14	1.19
MAND.	LEFT	70	23.76	.37	3.11	69	23.32	.14	1.19
		70	23.24	.14	1.15	68	22.96	.12	1.00
	ANT.	70	20.27	.21	1.78	69	20.09	.22	1.79
		70	18.28	.26	2.18	69	18.73	.25	2.06
	RIGHT	68	23.97	.14	1.18	68	23.25	.16	1.28
		70	23.23	.14	1.14	67	23.02	.13	1.07
TREATED - EXTRACTION PLANNED									
MAX.	LEFT	16	23.52	.43	1.73	14	23.26	.35	1.29
		16	23.33	.33	1.33	14	23.01	.27	1.03
	ANT.	16	26.06	.80	3.21	14	24.99	.55	2.07
		16	24.32	.47	1.87	14	23.32	.35	1.31
	RIGHT	16	23.69	.35	1.40	14	22.91	.42	1.58
		16	23.22	.32	1.29	14	22.81	.33	1.23
MAND.	LEFT	16	22.57	1.56	6.24	13	23.31	.33	1.19
		16	24.27	.30	1.19	13	23.28	.23	.81
	ANT.	16	19.26	.36	1.44	14	18.16	.43	1.60
		16	18.12	.85	3.39	14	17.96	.42	1.59
	RIGHT	15	24.14	.43	1.65	14	23.51	.26	.99
		16	24.36	.32	1.30	14	23.68	.22	.81

TABLE 37 Summary of spacing-crowding values in three segments per arch for Not treated, Treated non-extraction and Treated with extraction groups, in the NINE YEAR SUPERVISED SAMPLE PROJECTED BACK TO SIX YEARS.

MALES						FEMALES			
		N	Mean	SD _m	SD _s	N	Mean	SD _m	SD _s
<u>NOT TREATED</u>									
MAX.	LEFT	45	1.06	.07	.49	26	1.00	.14	.73
	ANT.	44	4.38	.31	2.05	26	4.32	.41	2.10
	RIGHT	45	.91	.07	.46	26	1.00	.13	.67
MAND.	LEFT	45	1.05	.09	.64	26	.81	.13	.67
	ANT.	45	2.28	.30	1.99	26	1.90	.43	2.20
	RIGHT	45	.92	.09	.58	26	.67	.16	.80
<u>TREATED NON-EXTRACTION</u>									
MAX.	LEFT	70	.91	.08	.63	68	.47	.16	1.33
	ANT.	70	3.76	.26	2.21	69	3.50	.25	2.04
	RIGHT	70	.95	.08	.70	68	.60	.09	.78
MAND.	LEFT	69	.86	.07	.56	68	.42	.11	.87
	ANT.	70	2.00	.24	1.97	69	1.36	.23	1.91
	RIGHT	68	.73	.07	.55	67	.28	.12	.98
<u>TREATED - EXTRACTION PLANNED</u>									
MAX.	LEFT	16	.19	.30	1.21	14	.25	.23	.87
	ANT.	16	1.74	.56	2.24	14	1.67	.40	1.50
	RIGHT	16	.48	.18	.72	14	.10	.33	1.24
MAND.	LEFT	15	-.19	.31	1.18	13	.03	.24	.86
	ANT.	16	1.14	.96	3.85	14	.21	.44	1.65
	RIGHT	15	-.31	.28	1.08	14	-.16	.19	.69

TABLE 38 Summary of arch relationship and arch dimension values for Not treated, Treated non-extraction and treated with extraction groups in the NINE YEAR SUPERVISED SAMPLE.

NOT TREATED	MALES				FEMALES			
	N	Mean	SD _m	SD _s	N	Mean	SD _m	SD _s
OVERJET I	45	3.90	.19	1.28	26	3.71	.16	.83
OVERJET II	42	1.11	.20	1.32	25	1.10	.22	1.12
MOLAR LEFT	45	.92	.26	1.72	25	.70	.17	.84
RELATIONSHIP RIGHT	45	1.28	.29	1.95	25	.96	.19	.95
CUSPID LEFT	39	.46	.24	1.52	21	.68	.28	1.30
RELATIONSHIP RIGHT	41	.57	.31	1.98	22	.40	.28	1.33
MIDLINE	42	.08	.12	.78	26	-.00	.15	.78
OVERBITE	45	2.77	.23	1.51	26	2.78	.25	1.27
ARCH MAXILLARY	45	30.08	.32	2.17	26	30.06	.32	1.61
LENGTH MANDIBULAR	45	26.24	.25	1.67	26	26.08	.23	1.19
ARCH MAX. < MOLAR	45	42.86	.37	2.45	26	42.04	.37	1.91
CUSPID	42	32.54	.31	2.01	24	32.14	.37	1.79
WIDTH MAND. < MOLAR	45	38.53	.31	2.10	26	37.31	.40	2.05
CUSPID	42	26.40	.26	1.65	22	25.07	.37	1.75
PALATE DEPTH	45	16.47	.33	2.20	26	16.12	.28	1.44
TREATED NON-EXTRACTION								
OVERJET I	69	4.26	.16	1.34	68	3.99	.13	1.10
OVERJET II	67	1.06	.16	1.32	65	1.27	.16	1.31
MOLAR LEFT	70	1.18	.22	1.88	68	.83	.18	1.50
RELATIONSHIP RIGHT	70	1.83	.22	1.80	68	.96	.18	1.50
CUSPID LEFT	62	1.14	.22	1.74	47	1.30	.24	1.64
RELATIONSHIP RIGHT	59	1.42	.22	1.69	50	1.24	.26	1.84
MIDLINE	68	.26	.12	1.00	68	.17	.12	.95
OVERBITE	69	3.22	.18	1.47	68	2.59	.17	1.38
ARCH MAXILLARY	69	30.35	.24	1.97	68	29.53	.19	1.53
LENGTH MANDIBULAR	70	26.55	.20	1.69	69	25.66	.18	1.47
ARCH MAX. < MOLAR	70	43.14	.24	1.99	69	41.97	.27	2.22
CUSPID	63	32.17	.23	1.81	57	31.34	.25	1.86
WIDTH MAND. < MOLAR	70	38.50	.24	1.97	69	37.36	.27	2.22
CUSPID	63	26.18	.23	1.85	48	25.40	.22	1.53
PALATE DEPTH	67	16.47	.19	1.51	66	16.13	.19	1.54
TREATED - EXTRACTION PLANNED								
OVERJET I	16	4.78	.66	2.63	14	4.69	.63	2.34
OVERJET II	16	1.44	.46	1.85	13	1.99	.75	2.72
MOLAR LEFT	16	1.26	.71	2.86	14	2.04	.51	1.92
RELATIONSHIP RIGHT	15	1.46	.56	2.17	14	1.94	.49	1.84
CUSPID LEFT	2	3.05	2.55	3.61	1	3.50	-	-
RELATIONSHIP RIGHT	2	3.30	.80	1.13	2	2.10	2.50	3.54
MIDLINE	16	-.13	.27	1.09	14	-.19	.33	1.24
OVERBITE	16	4.03	.24	.95	14	3.46	.58	2.17
ARCH MAXILLARY	16	29.05	1.37	5.46	14	28.31	.72	2.71
LENGTH MANDIBULAR	16	24.71	.47	1.88	14	24.38	.50	1.88
ARCH MAX. < MOLAR	16	41.76	.75	3.00	14	39.44	.63	2.37
CUSPID	2	30.55	.55	.78	2	30.00	.20	.28
WIDTH MAND. < MOLAR	16	37.09	.71	2.85	14	35.33	.52	1.95
CUSPID	5	24.82	.68	1.52	2	25.05	.35	.50
PALATE DEPTH	15	16.32	.50	1.94	13	16.73	.39	1.41

TABLE 39 Summary of arch relationships and arch dimension values for Not treated, Treated non-extraction and treated with extraction groups in the NINE YEAR SUPERVISED SAMPLE BACK TO SIX YEARS OF AGE.

MALES					FEMALES			
NOT TREATED	N	Mean	SD _m	SD _s	N	Mean	SD _m	SD _s
OVERJET I	38	2.73	.18	1.11	22	2.56	.17	.78
OVERJET II	38	.66	.19	1.15	21	.33	.10	.46
MOLAR LEFT	44	-.39	.17	1.15	26	-.25	.17	.89
RELATIONSHIP RIGHT	45	-.34	.19	1.24	26	-.18	.21	1.09
CUSPID LEFT	45	.86	.20	1.34	26	.92	.18	.92
RELATIONSHIP RIGHT	45	1.05	.20	1.36	26	1.20	.20	1.03
MIDLINE	35	.11	.12	.73	19	.20	.16	.68
OVERBITE	36	1.31	.25	1.51	22	1.61	.23	1.08
ARCH MAXILLARY	42	28.32	.29	1.89	23	27.93	.35	1.67
LENGTH MANDIBULAR	41	25.69	.26	1.63	25	25.66	.26	1.31
ARCH MAX. MOLAR	45	41.60	.34	2.27	26	40.45	.41	2.09
ARCH MAX. CUSPID	45	29.75	.33	2.19	26	29.40	.38	1.92
WIDTH MAND. MOLAR	45	37.53	.31	2.08	26	36.14	.38	1.92
WIDTH MAND. CUSPID	45	23.73	.29	1.93	26	23.25	.33	1.67
PALATE DEPTH	45	14.93	.17	1.15	26	14.85	.24	1.25
TREATED NON-EXTRACTION								
OVERJET I	63	3.13	.20	1.57	58	3.16	.22	1.66
OVERJET II	61	.90	.21	1.62	57	1.26	.24	1.81
MOLAR LEFT	68	.49	.20	1.62	63	.11	.18	1.46
RELATIONSHIP RIGHT	67	.65	.19	1.53	62	.14	.16	1.28
CUSPID LEFT	70	1.89	.20	1.66	69	1.52	.22	1.81
RELATIONSHIP RIGHT	70	2.21	.20	1.65	69	1.80	.17	1.43
MIDLINE	59	.19	.10	.78	57	.24	.15	1.10
OVERBITE	63	1.75	.19	1.52	59	1.01	.21	1.63
ARCH MAXILLARY	65	28.18	.22	1.73	64	27.83	.17	1.37
LENGTH MANDIBULAR	69	25.79	.20	1.63	64	25.12	.15	1.23
ARCH MAX. MOLAR	69	41.42	.26	2.13	68	40.16	.25	2.03
ARCH MAX. CUSPID	70	29.67	.23	1.89	69	28.79	.24	1.96
WIDTH MAND. MOLAR	70	37.48	.24	2.02	66	36.59	.25	2.02
WIDTH MAND. CUSPID	69	23.87	.20	1.65	69	23.59	.20	1.65
PALATE DEPTH	69	15.25	.17	1.41	67	14.88	.18	1.45
TREATED - EXTRACTION PLANNED								
OVERJET I	13	3.90	.68	2.47	13	3.22	.42	1.53
OVERJET II	13	1.76	.91	3.26	13	1.12	.52	1.89
MOLAR LEFT	13	.67	.50	1.78	13	-.35	.43	1.55
RELATIONSHIP RIGHT	15	.70	.44	1.69	13	.49	.51	1.83
CUSPID LEFT	15	2.31	.54	2.09	13	1.59	.50	1.80
RELATIONSHIP RIGHT	15	1.91	.52	2.02	13	2.00	.43	1.56
MIDLINE	11	.19	.16	.55	12	.20	.26	.89
OVERBITE	13	1.87	.31	1.13	13	1.22	.67	2.40
ARCH MAXILLARY	15	27.91	.81	3.13	13	27.55	.53	1.91
LENGTH MANDIBULAR	15	25.01	.51	1.97	13	24.71	.39	1.41
ARCH MAX. MOLAR	16	40.37	.69	2.75	14	38.92	.60	2.22
ARCH MAX. CUSPID	15	28.65	.49	1.90	13	27.18	.67	2.42
WIDTH MAND. MOLAR	16	36.63	.50	1.98	13	35.50	.55	1.98
WIDTH MAND. CUSPID	16	22.68	.52	2.07	13	21.63	.52	1.86
PALATE DEPTH	16	15.18	.38	1.53	13	15.49	.38	1.38

X TOOTH SIZE, SPACING-CROWDING, ARCH DIMENSION AND ARCH RELATIONSHIP
IN TWELVE YEAR OLD CHILDREN (CONTROL GROUP)

This report prepared by Allen Feldman

This study forms a part of the study done on the six and nine year old samples, and reported in progress report #5 (pp.78-114). The two main purposes of the study were, "... to establish standards for an untreated random sample for which the general demographic factors are the same as for the experimental group; second, a number of measurements will have to be made on the experimental group, for which as yet no satisfactory comparisons exist. These mostly have to do with the considerations of antero-posterior relationship of the lower to the upper jaw in terms of metric measures rather than the Angle classification".

This sample was made up of 208 children from the twelve year old control group. Table I describes this group according to age and sex.

Tables 9 and 10 give a breakdown of the number of teeth measured according to type and condition.

The definitions of the various measurements and descriptions of the methods used, which appeared in Report #5, were agreed upon before any final measuring was done and were applied to this work. There were a few exceptions which are noted below:

(1) The Antero-Posterior Relations of Anteriors II was not measured. It was felt that the method used was not a true measure of this dimension and another practical method could not be conceived. Further, it was felt that this measurement, even if it could be obtained, had very limited value.

The space occupied by this on the data sheets was used to record a second commonly-used measurement of the Antero-Posterior Relations of Anteriors I. This measurement was taken to the labio-incisal edge of the

incisors of the more anterior arch, rather than to the most prominent part of the tooth, and was done using a plastic millimeter ruler. The measurement was taken, as was the first one, parallel to the occlusal plane.

(2) The palatal depth was not measured as this investigator, rightly or wrongly, did not feel that he was getting an accurate reproducible measurement.

(3) The arch perimeter was measured to the mesial surfaces of the first permanent molars, rather than to the distal surfaces of the second bicuspid. The latter measurement was taken only if the first permanent molar was missing.

The purpose of this report is not to evaluate or interpret results, but only to tabulate and present the data gathered. The data is presented in the ten tables which follow.

It should be mentioned that Table #5 was included merely to help explain the apparent discrepancies in Table #4. For example: if we total the mandibular left teeth and the mandibular right teeth (33.76 and 33.75) we arrive at a total for the mandibular teeth of 67.51. But, the total mandibular teeth is given as 67.34. This difference is due to the fact that there are some cases having complete data on one side only. The side with complete data will be included in the average for that side. However, this measurement is not used when the total arch is considered. When these few cases are eliminated completely, the data tallies properly, as seen in Table #5. The few differences in the second decimal place are due to rounding off of the figures.

There is some further data which should be included in this report, but which I was not able to process in time. This data consists first of the error control studies done for the twelve year old age group.

After an interval of six months, all measurements taken were repeated for every twentieth case. The sole purpose of this was to determine whether or not the investigator was taking each measurement in the same manner at the beginning and end of the series.

The second bit of information has to do with double determinations done by the two investigators directly concerned with the measuring. Eighteen cases, six from the twelve year group, six from the nine year group, and six from the six year group were measured by Dr. Hunter and again by myself. The purpose of this double determination is to see whether there is a significant difference in any of the measurements taken. If no significant difference is found, it will enable one to more safely compare and combine the two sets of data. This information has been collected. It will be processed and will appear in Progress Report #7.

Table 1

AVERAGE AGE IN MONTHS FOR THE SUBJECTS OF THIS INVESTIGATION

12 YEAR OLD CONTROL GROUP

The casts of eleven subjects were not measured due to extensive caries, tooth loss and banding of the teeth.

Twelve year group	N	Average age in months	S.D. _{$\bar{x}$}	S.D. _s
Males	113	144.5	.223	2.51
Females	95	144.4	.141	1.64
Total	208			

Table 2

Mesiodistal Crown Diameters of Unrestored, Non-carious permanent teeth. No "Antimere" or "Unreliable" measures were used.

		MAXILLA					Right					
		Left										
		N	Mean(mm.) $\bar{x}$	S.D. $\bar{x}$	S.D. s	C.V.%	N	Mean $\bar{x}$	(mm.)	S.D. $\bar{x}$	S.D. s	C.V.%
I 1	M	107	8.84	0.053	0.55	6.21	108	8.91		0.054	0.57	6.37
	F	91	8.62	0.064	0.61	7.11	92		8.64	0.057	0.55	6.41
I 2	M	104	6.84	0.052	0.53	7.77	109	6.94		0.052	0.55	7.92
	F	91	6.59	0.057	0.54	8.23	91		6.67	0.059	0.57	8.55
C	M	66	8.01	0.047	0.38	4.78	60	8.08		0.054	0.42	5.23
	F	69	7.63	0.051	0.43	5.60	70		7.71	0.042	0.36	4.65
P 1	M	90	7.15	0.046	0.44	6.21	82	7.17		0.046	0.42	5.87
	F	81	6.97	0.039	0.35	5.09	79		6.93	0.041	0.37	5.29
P 2	M	73	6.94	0.052	0.44	6.40	72	7.01		0.048	0.41	5.84
	F	69	6.73	0.040	0.34	4.98	68		6.77	0.041	0.35	5.14
M 1	M	70	10.63	0.059	0.50	4.72	74	10.54		0.069	0.60	5.67
	F	59	10.33	0.052	0.40	3.88	54		10.28	0.067	0.49	4.81

Table 3

		MANDIBLE					Right					
		Left										
		N	Mean(mm.) x	S.D. x	S.D. s	C.V.%	N	Mean x	(mm.)	S.D. x	S.D. s	C.V.%
I 1	M	111	5.53	0.028	0.31	5.66	111	5.53		0.032	0.33	6.04
	F	92	5.43	0.035	0.34	6.36	93	5.44		0.035	0.34	6.33
I 2	M	108	6.10	0.033	0.36	5.82	111	6.06		0.030	0.32	5.36
	F	95	5.95	0.040	0.39	6.55	94	5.92		0.037	0.37	6.23
C	M	98	7.09	0.035	0.36	5.02	97	7.09		0.036	0.36	5.10
	F	91	6.66	0.036	0.35	5.23	91	6.65		0.039	0.38	5.65
P 1	M	90	7.24	0.046	0.44	6.09	92	7.21		0.045	0.43	5.96
	F	86	7.05	0.044	0.41	5.81	89	7.06		0.042	0.41	5.75
P 2	M	77	7.33	0.051	0.45	6.20	69	7.33		0.054	0.45	6.13
	F	69	7.19	0.042	0.35	4.91	71	7.22		0.042	0.36	5.00
M 1	M	71	11.29	0.069	0.58	5.18	76	11.29		0.076	0.66	5.89
	F	47	10.90	0.077	0.53	4.88	48	10.85		0.075	0.52	4.78

Table 4

Means for arch length and tooth material for maximum data, using filled, carious and opposite side teeth.

12 years	MALES					FEMALES				
	Mean (mm.)			S.D. _m	S.D. _s	Mean (mm.)			S.D. _m	S.D. _s
	N	ARCH	TEETH			N	ARCH	TEETH		
Maxillary	111	38.62		.24	2.51	95	36.64		.23	2.25
Left	84		37.99	.20	1.84	80		36.78	.20	1.83
Maxillary	111	38.14		.24	2.49	95	36.63		.21	2.08
Right	83		38.06	.19	1.71	81		36.84	.19	1.75
Total Maxillary Arch	111	76.76		.43	4.58	95	73.27		.42	4.10
Total Maxillary Teeth	82		76.05	.38	3.44	79		73.71	.38	3.40
Mandibular	112	33.58		.22	2.36	95	32.36		.21	2.01
Left	98		33.76	.19	1.87	88		32.55	.18	1.71
Mandibular	112	33.93		.23	2.46	95	32.72		.22	2.18
Right	98		33.75	.18	1.81	88		32.73	.19	1.76
Total Mandibular Arch	112	67.51		.41	4.38	95	65.09		.38	3.74
Total Mandibular Teeth	96		67.34	.35	3.41	87		65.29	.36	3.36

Table 5

Means for arch length and tooth material using only cards with complete data:
(ie. no missing data)

12 YR. GROUP	MALES					FEMALES				
	Mean (mm.)					Mean (mm.)				
	N	ARCH	TEETH	S.D. _m	S.D. _s	N	ARCH	TEETH	S.D. _m	S.D. _s
Maxillary	73	38.58		.28	2.38	79	36.98		.23	2.07
Left	73		38.00	.22	1.86	79		36.83	.20	1.82
Maxillary	73	38.51		.25	2.13	79	37.02		.21	1.87
Right	73		38.02	.20	1.71	79		37.00	.18	1.63
Total Maxillary Arch	73	77.09		.49	4.15	79	74.00		.42	3.70
Total Maxillary Teeth	73		76.02	.40	3.41	79		73.84	.38	3.36
Mandibular	73	33.68		.25	2.16	79	32.62		.19	1.66
Left	73		33.45	.20	1.68	79		32.54	.19	1.70
Mandibular	73	33.91		.24	2.02	79	33.02		.22	1.99
Right	73		33.40	.18	1.57	79		32.68	.20	1.79
Total Mandibular Arch	73	67.58		.45	3.88	79	65.64		.37	3.30
Total Mandibular Teeth	73		66.86	.37	3.18	79		65.23	.38	3.40

Table 6

Average spacing - crowding values for maximum data using restored, carious, and opposite side teeth. A plus value indicates spacing to the extent of the associated value. A negative value indicates crowding.

12 year group	MALES				FEMALES			
	N	Mean in $\frac{\text{mm}}{x}$	S.D. $\frac{x}{x}$	S.D. s	N	Mean in $\frac{\text{mm}}{x}$	S.D. $\frac{x}{x}$	S.D. s
Maxillary left	84	0.523	0.19	1.77	80	0.07	0.20	1.76
Maxillary right	83	0.33	0.19	1.75	81	-0.002	0.19	1.68
Maxilla	82	0.84	0.34	3.10	79	0.05	0.35	3.14
Mandibular left	98	0.06	0.20	1.96	88	0.05	0.20	1.83
Mandibular right	98	0.29	0.20	2.02	88	0.26	0.21	1.98
Mandible	96	0.41	0.35	3.45	87	0.23	0.36	3.36

Table 7

Average spacing - crowding values for data computed for arches containing no missing or restored teeth. A plus value indicates spacing and A negative value indicates crowding.

12 year group	MALES				FEMALES			
	N	Mean in <u>mm.</u> x	S.D. x	S.D. s	N	Mean in <u>mm.</u> x	S.D. x	S.D. s
Maxillary left	65	0.77	0.22	1.77	63	0.16	0.23	1.82
Maxillary right	65	0.59	0.20	1.58	63	-0.03	0.23	1.80
Maxilla	65	1.37	0.36	2.90	63	0.12	0.42	3.33
Mandibular left	65	0.39	0.22	1.78	63	0.20	0.22	1.72
Mandibular right	65	0.66	0.22	1.79	63	0.43	0.27	2.12
Mandible	65	1.05	0.41	3.27	63	0.63	0.44	3.52

Table 8

SUMMARY OF THE MEAN VALUES FOR THE VARIOUS
ARCH RELATIONSHIP MEASURES MADE FOR THE TWELVE YEAR GROUP

		N	MEAN (mm.) $\bar{x}$		S.D. $\bar{x}$	S.D. s
Overjet I	M	111	4.43		.185	1.95
	F	94		4.13	.191	1.85
Overjet II	M	112	3.97		.195	2.07
	F	94		3.54	.191	1.86
Molar Relation-right ship	left M	104	0.73		.199	2.03
	F	83		0.59	.232	2.12
	M	106	1.29		.195	2.01
	F	81		1.20	.204	1.84
Cuspid Relation-right ship	left M	96	2.78		.238	2.33
	F	94		3.19	.257	2.49
	M	95	2.82		.236	2.31
	F	90		3.07	.241	2.29
Midline	M	112	-0.007		.116	1.23
	F	95		-0.034	.134	1.31
Overbite	M	113	3.89		.147	1.57
	F	95		3.31	.159	1.55
ARCH LENGTH	Maxilla M	107	30.49		.237	2.45
	F	90		28.97	.245	2.33
	M	107	25.87		.198	2.05
	Mandible F	82		24.99	.234	2.12
ARCH WIDTH	Molar M	107	44.83		.254	2.63
	F	90		43.17	.280	2.66
	Max. Cuspid M	96	33.69		.239	2.34
	F	91		32.09	.275	2.63
ARCH WIDTH	Molar M	107	39.62		.230	2.39
	Mand. F	82		38.33	.265	2.40
	Cuspid M	105	25.95		.170	1.74
	F	95		25.45	.181	1.76

Table 9

SUMMARY OF TYPES OF TEETH AND MEASUREMENTS

MADE FOR THE TWELVE YEAR OLD AGE GROUP

F E M A L E

N = 95		LEFT						RIGHT					
MAXILLA	CODE NO.	I ₁	I ₂	C	P ₁	P ₂	M ₁	I ₁	I ₂	C	P ₁	P ₂	M ₁
	0	-	4	5	6	2	12	-	4	6	4	2	14
	1	-	-	7	2	7	-	-	-	11	3	12	-
	2	91	91	69	81	69	59	92	91	70	79	68	54
	3	-	-	-	1	5	-	-	-	1	1	3	-
	4	1	-	13	2	3	-	1	-	6	4	5	1
	5	-	-	-	-	-	-	-	-	-	-	1	-
	6	3	-	-	3	4	24	1	-	-	3	1	25
	7	-	-	1	-	5	-	1	-	1	1	3	1
MANDIBLE													
	0	-	-	2	2	4	16	1	-	2	3	3	22
	1	-	-	-	2	5	-	-	-	-	1	9	-
	2	92	95	91	86	69	47	93	94	91	89	71	48
	3	-	-	-	-	2	-	-	-	-	-	5	-
	4	2	-	2	4	8	1	1	1	2	2	2	-
	5	-	-	-	-	1	-	-	-	-	-	2	-
	6	1	-	-	1	5	31	-	-	-	-	1	22
	7	-	-	-	-	1	-	-	-	-	-	2	3

Explanation of Coding:

- 0 - tooth missing, banded, badly carious, ie. no measure
- 1 - primary tooth - not carious or restored
- 2 - permanent tooth - not carious or restored
- 3 - primary tooth - proximal restoration
- 4 - antimere used
- 5 - difficult to measure
- 6 - permanent tooth - restoration
- 7 - caries - but measured

Table 10

SUMMARY OF TYPES OF TEETH AND MEASUREMENTS

MADE FOR THE TWELVE YEAR OLD AGE GROUP

M A L E

N = 113

MAXILLA

CODE NO.	LEFT						RIGHT					
	I ₁	I ₂	C	P ₁	P ₂	M ₁	I ₁	I ₂	C	P ₁	P ₂	M ₁
0	-	2	23	8	10	9	-	2	22	7	8	10
1	-	-	15	4	14	-	-	1	19	5	14	-
2	107	104	66	90	73	70	108	109	60	82	72	74
3	-	-	-	3	6	-	-	-	-	3	6	-
4	-	1	9	3	2	-	2	-	11	8	8	1
5	-	-	-	1	-	-	-	-	-	1	-	-
6	6	5	-	1	2	31	3	1	-	4	2	27
7	-	1	-	3	6	3	-	-	1	3	3	1
MANDIBLE												
0	1	2	7	3	6	13	1	1	7	5	8	13
1	-	-	2	5	11	-	-	-	6	6	13	-
2	111	108	98	90	77	71	111	111	97	91	69	76
3	-	-	-	2	8	-	-	-	-	2	6	-
4	-	-	6	11	4	-	1	-	3	3	8	-
5	-	-	-	1	1	1	-	-	-	1	2	-
6	1	3	-	1	2	26	-	-	-	1	2	22
7	-	-	-	-	4	2	-	1	-	4	5	2

Explanation of Coding:

- 0 = tooth missing, banded, badly carious, ie. no measure
- 1 = primary tooth - not carious or restored
- 2 = permanent tooth - not carious or restored
- 3 = primary tooth - proximal restoration
- 4 = antimere used
- 5 = difficult to measure
- 6 = permanent tooth - restoration
- 7 = caries - but measured

XI THOUGHTS ON FUTURE PLANS

M. Hatton

During the next year cranio-facial characteristics and malocclusion manifestations in the treated sample at age 10 and 12 years will be compared with the cross-sectional cases of the same age. This study facilitates not only direct comparisons between the children who have been receiving preventive - interceptive therapy and those who have not, but beyond this it makes available information derived from a serial sample of untreated cases. It is clear that only through comparisons of treated samples with untreated samples can information regarding population differences be derived, nevertheless, in the final analysis, the real measure of the efficacy of preventive-interceptive procedures can only be derived from proper analyses of the serial treated cases. These individuals may well be compared with serial untreated cases at similar chronological ages, or cross-sectional untreated cases at similar chronological ages, the fact remains that whereas valuable information may be derived from such comparisons, they are nevertheless beset with difficulties. The treated serial group obviously implies that only the children who required treatment received it, so that in fact there are only a certain number within the sample who were really treated; the untreated samples too, are not truly untreated in so far as these samples are bound to include individuals privately treated. It would seem rather essential, therefore, that each type of defect within the so-called serial treated sample should be regarded as a discreet problem which has received rather special attention. The answer as to whether the attention has had successful, adequate, fair or useless results will surely not be found by observing other children but rather by observing the children who received the attention. The question is really one of whether or not the anticipated problem has been prevented

or intercepted. If indeed the defect persists as the serial records will readily indicate, then the answer is obvious. Counts of failures or successes of this type should provide a real measure of the efficacy of the programme. This is not to say that comparisons between samples are undesirable, but rather that extreme caution must be exercised in examining the results lest they be assigned a spurious interpretation.

Attention will also be paid to the pedigree study. The ultimate aim of this investigation is to determine the mode of inheritance of certain cranio-facial characteristics, and for this reason this is a long range study in its truest sense. The quite extensive body of records which has now been gathered on the 175 families taking part in this project will be analysed. The immediate plan is to make inter- and intra-family comparisons of the same cranio-facial characteristics that were studied in the representative sample.

XIII FUTURE PLANS - R. M. Grainger

Termination Date. The major work of collecting data and conduct of treatment for the serial group up to 12 years of age should be completed by March, 1963. After this date there will be an unavoidable "clean-up" period with reduced staff to finally complete some few remaining treatment cases and secure some final records for individuals whose 12th birthday happen to come in the latter months of the year.

Consolidation of Records. The records are to be housed permanently in the Faculty of Dentistry, University of Toronto under library regulations so that they may be permanently preserved and readily available for study by students to whom they are of interest. The establishment of a system which will guarantee the safety and availability of the records is itself a considerable task and some funds will be necessary on a more or less permanent basis for salary of a librarian and for duplication of a set of records to be held in reserve.

Extended Studies. It is hoped that the Burlington Research Clinic can be kept open as the site for new studies after the termination of the present project. Among those most high in priority are:

- (1) the genetic study which cannot be closed down at the same time as the interceptive orthodontic study due to the fact that records of siblings must be obtained as they or their twins reach certain ages.
- (2) it is felt that the study of malocclusion cannot be completed without following as many as possible of the children until the eruption of the third molars when it is known regression often occurs due to crowding of the arch. For this purpose consideration is being given to a study of malocclusion among teen age children.

- (3) In addition to the studies of malocclusion the value of the present records may be compounded by a study of incipient periodontal disease as it occurs in the same individuals for whom the records are now available since birth. This opportunity to study predisposing factors in periodontal disease is quite unique and if superimposed on the orthodontic records would represent a huge financial and time saving.

Reporting on Primary Questions

It is expected that the primary objectives will be reached by the termination date and will be reported in the last of the serial reports in detail.

With particular reference to the evaluation of interceptive treatment this will be approached as stated in the second report series by comparing the relative frequency of specific defects in the serial and control groups at age specific levels. In addition however, longitudinal study of individuals who have received a particular treatment are expected to give rather obvious answer to the question of treatment success. As is pointed out in the paper by Hunter, (page 40) the results of the treatment are not expected to be apparent in terms of changes in average dimensions.

Consolidation of the Report Series. After termination of the active study it is anticipated that the parts of the serial reports which have proved themselves to be useful will be consolidated into a single report for distribution on as wide a basis as demanded.

XIII (a) A Study of the Relation between Various Cranio-Facial
Features and the Functional Occlusal Plane

Investigator: Peter G. Peloso

AIM To determine the relation between the relative prominence of basal bone, measured by projecting perpendiculars from "A" and "B" points to the functional occlusal plane; and
(a) The cranial base; (b) The facial profile, Nasion-Subnasale-Pogonion; (c) The inclination of the upper central incisor to the natural occlusal plane.

MATERIAL 273 Lateral head plate films of children 6 years of age from the Six Year Control Group of children were used for this study.

RESULTS Results were compared with similar observations on the same children at 9 years of age.

It was concluded that:-

1. Profiles provide little information regarding type of occlusion.
2. The cranium is a poor source of reference from which to measure aspects of occlusion because of its relative independence from occlusion.

XIII (b) A Study of Symmetry in Premolar, Deciduous Molar, and
First Permanent Molar Position in Six Year Old Children

Investigator: Robert Hamilton

AIM The primary aim of the study was to present a critical statistical expression for the normal position of mandibular buccal teeth in six year old children. Such an expression for normalcy seemed desirable since it might provide a starting point for workers interested in studying abnormal tooth position and abnormal tooth movement.

There are slight asymmetries in position between fully homologous organs in the two halves of the body. This study was based on the slight asymmetries between positions of corresponding teeth relative to symphysis point.

MATERIAL The study was based on the right and left oblique cephalometric x-rays of 276 cases comprising the six year old control group of the Burlington Orthodontic Research Centre. Cephalograms were reproduced as photographic prints before measurements were made.

METHOD Positions of teeth relative to symphysis point were measured by dropping perpendiculars from the most mesial tooth surfaces to a line drawn tangent to the most anterior masseter muscle attachment on the inferior border of the body of the mandible and intersecting symphysis point. Distances from symphysis point to extension lines from teeth on the left side were subtracted from distances from symphysis point to extension lines from teeth on the right side.

A similar procedure was carried out for differences between right and left sides of the mandible.

RESULTS:

1. Teeth on left side of mandible tend to be further from symphysis point than corresponding teeth on the right side of the mandible.
2. There is a tendency for mandibular first permanent molars to move anteriorly when the adjacent second deciduous molar in front is lost. At age six, however, this tendency does not appear pronounced enough to warrant intra-alveolar space maintainers for all such cases.
3. Mandibular first permanent molar position remains remarkably constant antero-posteriorly relative to symphysis point between the ages of six and nine (material on same children at nine years of age taken from the study of V. M. Flores-Estrada).
4. Variation in mandibular first permanent molar position between right and left sides is rather independent of variation in length between right and left halves of the mandible.

XIII (c) An Evaluation of Symmetry in Length of the Mandible and Mandibular Tooth Position

Investigator - V.M. Flores Estrada (This abstract was prepared by
M. E. Hatton)

Introduction -

The aim of this investigation was to determine the degree of symmetry not only in the two sides of the mandible but also in the position and movement of the teeth in this jaw.

Sample: - The sample included 230 nine year old children, the original six year old serial control sample. Of this group 85 males and 25 females had normally developing dentitions in which no loss of deciduous molars had occurred.

Method: - Contact prints made from left and right oblique cephalograms were used for a series of measurements which included:

1. Mandibular Length - The distance between symphysis point and the most distal point on the head of the condyle.

2. Tooth Position - The distance between the most mesial points of $\overline{6/6}$; $\overline{5/5}$; $\overline{4/4}$; $\overline{e/e}$; $\overline{d/d}$; and symphysis point, taken along a tangent to the inferior border of the mandible and passing through symphysis point. This tangent was called the reference plane.

Results: -

1. A critical pattern of normalcy in mandibular tooth position in nine year old children with normally developing dentitions, in which no loss of deciduous molars has occurred, was established.

2. An extraordinary stability of the lower first permanent molar, between ages six and nine, in children with their deciduous molars present, has been demonstrated.

3. Lower second bicuspid showed a slight, but consistent, distal movement in the same group of children.
4. Of significant importance was the definite distal movement, showed by the first premolars in the alveolar bone, between ages 6 and 9.
5. These last three findings are considered sufficient evidence to reject theories based on the forward movement of the teeth, as deduced from studies of comparative anatomy.
6. A tendency towards mesial movement of the lower first permanent molars, even though only to a very slight degree, was found in cases with loss of deciduous molars.
7. Asymmetry in tooth position was found to be expressed in a shorter distance from symphysis to teeth on the right side, in children with all deciduous molars present at age nine.
8. The asymmetry was found more significant for boys than for girls.
9. No significant difference was found between length of the mandible in the male group, at age nine.
10. An asymmetry in length of the mandible, showing that the right side was larger than the left, was found in the female group at age nine.
11. Further investigation in the study of the symmetry of mandibular length at later age is advisable.

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